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ABSTRACT

Part of a series of working papers intended to stimulate research, education, dialogue, and political action in favor of a more just world order, this monograph relates technology to four major global issues--energy, environment, employment, and equity. The objective is to determine the kinds of technological choices that can be made regarding social change in these four areas to diminish structural and other forms of violence against humanity and the biosphere. Six assumptions underlie the premise that technology can influence developments in these global issue areas: (1) obvious inequalities exist between developed and developing nations in areas of energy consumption, income distribution, material deprivation, economic and political power, and science-based problem-solving capacity; (2) developing nations are becoming increasingly dependent on developed nations; (3) technology is emerging as a major instrument for domination; (4) technology facilitates social change; (5) indigenous technologies in developing nations should be nurtured; and (6) depletion of natural resources cannot continue indefinitely. Some propositions are made to accelerate the transition away from exploitation and oppression of developing nations and toward equality of all peoples, including creating autonomous Third World structures for economic and technological intelligence, revitalizing indigenous technologies in the Third World, and encouraging ecologically sound productive processes (such as solar energy) in the industrialized nations. The conclusion is that technology should be recognized as an extremely potent force which should be judged in terms of its harmony with social and physical environments. (DB)

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Separate, Unequal, But More Autonomous: Technology, Equity and World Order in the Millennial Transition

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WORLD ORDER MODELS PROJECT
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This paper is one in a series of working papers commissioned by the World Order Models Project in its effort to stimulate research, education, dialogue, and political action which will contribute to a movement for a just world order. The papers will deal with major global problems facing humanity, and particularly vexing contemporary political, economic, social, and cultural issues within an analytic and normative framework guided by the concepts and values of peace, economic well-being, social justice, and ecological stability. Special emphasis will be given to the necessity and feasibility of structural transformation of today's fragmented world in order to resolve these problems and achieve just world order results.

A Working Group of the World Order Models Project (WOMP) will use these papers in its new program aimed at publishing a statement in 1980 outlining the strategies for realizing just world order during this century. We invite interested individuals throughout the globe to respond to the various papers either directly to the individual authors or to WOMP. These communications will figure significantly in the WOMP Working Group's final statement. Where appropriate, the responses and critiques will be published in *Alternatives: A Journal of World Policy*.

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SEPARATE, UNEQUAL, BUT MORE AUTONOMOUS: TECHNOLOGY, EQUITY AND WORLD ORDER IN THE MILLENNIAL TRANSITION*

Ward MOREHOUSE†

On the threshold of the millennial transition of the next 20–40 years, the human community is confronted with four alliterative crises which will reach a crescendo in the 1980s: energy, environment, employment, and equity. Breakdowns in capital- and energy-intensive systems are increasingly likely in the industrially advanced countries of the North and in the so-called modern sectors of Third World economies. As pressure on non-renewable resources and the environment grows, more and more effort is being made through organized R&D in the North to find technological solutions or fixes to these problems. The revolutionary advances occurring in micro-electronics and biotechnology can have dramatic impact on life-styles in the North and South, and on the global political economy. The key issues of the millennial transition, however, will not be technological but economic and political, revolving around the question of control over these technological innovations. Greater economic, political and technological integration of the world will draw the peripheral nations of the Third World more tightly into a web of continuing dependence; and therefore selective disengagement of the South from the North emerges as a 'lesser evil' transitional strategy, while the South seeks to strengthen its own local problem-solving skills to grapple with the alliterative crises of the 1980s. In this effort, the South must use more extensively its own *existing* survival technology – indigenously based knowledge and skills which most people in the Third World live by today – in judicious combination with new advanced technologies from the North, if it can exercise reasonable control over the acquisition and utilization of those technologies.

* I am indebted to Claude Alvares, Ashis Nandy and Nancy Todd for comments on an earlier draft of this paper. Needless to say, they are not responsible for the result, the more so because I have chosen to ignore some of their suggestions even though accepting most of them.

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The millennial transition

As we enter the last two decades of the twentieth century, we are approaching the end of one millenium and are about to begin another, according to currently prevailing chronology.[1] But it is not just an arbitrary method of counting time which signals us that a watershed in human history is at hand.

Evidence is steadily accumulating that the human community cannot continue very much longer in the style of recent decades. E.F. Schumacher reminds us, through dexterous use of basic concepts in modern economics illustrating why proponents of that dismal science will sooner or later be proven irrefutably wrong, that we are consuming capital at an alarming rate. Every student of elementary economics knows that this consumption pattern cannot go on for long. Sooner or later, something has to change.[2]

The capital to which Schumacher refers is non-renewable natural resources, especially energy, and the physical environment. He makes an interesting extrapolation involving world fuel consumption to underscore his point that the rich segment of the human community is 'stripping the world of its once-for-all endowment of relatively cheap and simple fuels'.[3] The following table of population and fuel consumption in the year 2000 is based on the assumptions that the rich and poor populations will grow at annual rates of 1·25% and 2·25% respectively and that per capita fuel consumption will increase by 2·25% per year for the rich and 4·5% for the poor.

The accuracy of these figures need not detain us. Others have used different figures and come to essentially the same conclusion. Even if we assume a much more rapid rate of growth in fuel consumption by the poor countries, the rich will still be using a far greater share by the end of the millennium. A second equally important point Schumacher puts as a question: 'Is it plausible that world fuel consumption *could* grow to anything like 23 000

[1] I have no particular brief for Christian chronology, although it does appear, in fact, to be widely accepted, even in non-Christian parts of the world. Buddhist, Islamic, or any other chronology would do just as well if it were similarly accepted. While the global acceptance of Christian chronology is no doubt symbolic of political reality, efforts to substitute something else for it strike me as epiphenomenal in substantive consequences. Calendar reform is another matter; the present 12-month Western calendar, with complete lack of congruence with weekdays, is ridiculous and should be changed forthwith to a 13-month calendar.

[2] E.F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (New York : Harper and Row, Perennial Library Edition, 1973), especially Part 1 on 'The Modern World'.

[3] ibid., p. 28.

Table 1
Population and fuel consumption in the year 2000

Rich (%)	Poor (%)	World (%)
Population (millions)		
1617 (23)	5292 (77)	6909 (100)
Fuel consumption (million tons of coal equivalent)		
15 588 (67)	7568 (33)	23 156 (100)
Fuel consumption per capita (tons of coal equivalent)		
9·64	1·43	3·35

Source: E.F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (New York: Harper and Row, 1973).

million tons (from 5500 million in 1966, Schumacher's base year) coal equivalent a year by the year 2000, using 425 000 million tons i.e. during the thirty-four years in question?'[4] And even if it could, would it be able to continue very long thereafter at that rate of consumption? And would environmental consequences in terms only of thermal pollution be manageable?

The answer to each question is, of course, No. The only question remaining is the precise time by which the present dominant system of production in the world will change or collapse. This system is based on energy-intensive technology and supports a style of living in rich countries (and among the rich in poor countries) which seems hell-bent on using up the world's 'natural capital' as fast as possible. This 'natural capital' was not created by man but was simply found by him; he cannot replace it once it is gone.

Indeed, some observers would argue that the process of breakdown in affluent life-styles in the West, and in the global system of production and exploitation which sustains them, has already begun. Each commentator on the human condition will offer a different list of crises which must be surmounted over the next 20 to 40 years as part of the transition to the next millennium. I identify four, perhaps because of their alliterative character, as becoming particularly critical in the 1980s: energy, environment, employment, and equity.

The task for the human community in the millennial transition will be to cope with these crises as we move to, in Schumacher's felicitous phrase, an 'economics of permanence'. The normative goal is to grapple with crises, such as energy and environment, while vastly increasing opportunities for meaningful and productive work and for realizing a far greater measure of other aspects of social equity than now characterizes our troubled, unbalanced world.

[4]ibid., p. 27 (emphasis original).

My view of the millennial transition, however, is not a thinly disguised articulation of the limits-to-growth thesis. That thesis, even in its more recent and sophisticated restatements, does not square with economic and political reality, certainly not during the millennial transition. Economic growth will continue to occur in the Third World because there is no other way to meet the most minimal requirements for survival. And in the advanced industrialized societies, the momentum within economies organized around the proposition of continuing growth is simply too great and political pressure for a 'better life' by those who think they do not yet have it, unrelenting.

Furthermore, new resources will be discovered to alleviate shortages of raw materials for a time, and new technology will help us discover substitutes for those in short supply. These steps will enhance performance of basic economic functions in less energy intensive, environmentally destructive ways. The character of growth will have to change radically, however, from the raw physical growth of the last 30 years to a far more energy, raw material and environment-conserving pattern; again, some would argue that this process has begun.

But none of this invalidates the Schumacherian line of argumentation, which seems remarkably prescient a decade after it was articulated. In fact, increasingly ominous evidence concerning the irreversibility of carbon dioxide buildup in the biosphere suggests that Schumacher may have understated the seriousness of the problem since this buildup introduces the prospect of dramatic, if not catastrophic, climate change.

Further, anyone who thinks that the energy, environmental, employment, and equity crises of the 1980s will be solved through a succession of technological fixes should have his or her head examined. While technological change will both help and complicate efforts of the human community to grapple with these crises, the critical struggles will be, as they have so clearly been in the past 30 (or 300) years, economic and political. The key issue is control, and the proper question to ask concerning any significant technological change is, to paraphrase one of the classic definitions of politics: Who gets what, when, where, why, how (and how much)?

The South is at an enormous disadvantage in the struggle for control over new technologies because so much of the capacity for generating these technologies lies in the North. It is by now abundantly clear that the aggressive and *indiscriminate* export of Northern technologies, not only perpetuates Southern dependence, but aggravates the alliterative crises of the 1980s. But the South has its own 'secret weapon' if it will only use it: protection, revitalization, and dissemination of its own indigenous technologies.

A central argument in this paper is that to accomplish the millennial transition, the South must use its own *existing* technological base of

knowledge and skills far more extensively than it has, in judicious combination with new advanced technologies from the North – as long as the South can exercise reasonable control over the acquisition and utilization of those Northern technologies.

Within this sweeping range of challenges and opportunities, the focus here is on technology as a critical variable that both exacerbates the crises now before the human community and helps the community to surmount these crises as we move through the millennial transition. We need to know what kinds of technological choices can be made to diminish structural and other forms of violence against humanity and our biosphere while enhancing equity and the durability of human civilization, and what economic, social, and political chemistry is necessary to make these choices possible or inevitable.

There are, needless to say, no simple answers to such questions, and this paper will not provide them. Its objective is more modest but still ambitious enough: to identify significant problems and critical leverage points at which technology, used as a general dependent variable in the process of social change, can make a difference as we struggle through the millennial transition and strive to reach the brave new world which lies beyond. To the extent that this objective is realized, the paper should serve as a stimulus to further study, dialogue and action leading to a more just and equitable world.

Assumptions and assertions: the basic thesis in a nutshell

Six assumptions underlie our argument:

(1) The late twentieth-century world is a highly unequal place in energy consumption, income distribution, material deprivation, economic and political power, and science-based problem-solving capacity. Ninety-seven percent of the world's expenditure on research and development is made by a handful of industrialized countries; most of the Earth is a scientific desert.[5] The social benefits and costs of this maldistribution of scientific effort are clearly debatable.

(2) As long as the world is characterized by such extremes in the distribution of power, the capacity to use resources and the ability to increase production through economically and politically purposeful effort on a

[5]See the latest global survey by Jan Annerstedt, *A Survey of World Research and Development Efforts: The Distribution of Human and Financial Resources Devoted to Research and Experimental Development in 1973* (Paris and Roskilde, Denmark: OECD Development Centre and Institute of Economics and Planning, Roskilde University Centre, July 1979). Some further comments on the global maldistribution question are given in Appendix 2.

substantial scale, greater integration of the world economically, politically, or technologically will draw the periphery nations of the Third World more tightly into a web of continuing dependence.

(3) Technology is rapidly emerging as a major instrument for global domination as other economic and military forms of power decline for stronger nations in the international system.

(4) Science-based technology is not latter-day alchemy.[6] It cannot transform the social landscape in and of itself. It is an instrument for good or evil (more evil than good in recent decades in terms of its impact on ecological balance and social equity). On the other hand, it can make possible or facilitate certain kinds of social change, both desirable and undesirable.

(5) The South has major problem-solving capacities of its own with regard to the relationship between its reservoir of indigenous technological knowledge and skills (accumulated over hundreds of years and finely tuned to human survival) and the 'economics of permanence'. Instead of being aggressively destroyed through the imposition of so-called advanced Northern technologies, these indigenous technologies need to be nurtured, revitalized, and promoted.

(6) The dominant late twentieth-century world system of production and consumption, based on rapid utilization of the Earth's 'natural capital' in non-renewable resources and in the capacity of the biosphere to serve as a sink for wastes and pollutants, cannot go on much longer. If the system does not change, it will collapse of its own weight.

These six assumptions lead to two propositions:

(1) The world is more likely to achieve a less unequal, more equitable future if, during the millennial transition, the South seeks selective disengagement – economically, politically, and technologically – from the North while strengthening its autonomous capacity to solve its own problems and increase its own productive capabilities to meet its needs.[7]

(2) While there is no assurance that greater autonomy will lead to increased equity, few nations have proceeded very far in this century in meeting the minimum material needs of most of their people on a *self-sustaining* basis without greatly strengthened autonomy.[8]

The balance of this paper is devoted to arguing my basic thesis, beginning with an examination of our present predicament and then moving on to some key 'transitional technologies' that can help us move from this millennium to the next. I conclude with some programmatic and political next

[6]The relationship between science and technology is briefly discussed in Appendix 1.
[7]Disengagement and autonomy, technological and otherwise, are defined in Appendix 1.
[8]The relationship between autonomy and equity is examined in Appendix 1.

steps, at varying levels of specificity, which could lead to the transformation of today's troubled, unequal world into a more just, equitable future. The appendices provide definitions of basic terms and concepts used in the paper, their relationships to one another (autonomy, equity, technology, and science) and brief comments on the existing global maldistribution of modern science and technology-based problem-solving resources and activity.

The role of technology in social change

The present predicament of the human community has origins deep in history and is intimately linked to the growth of modern science and technology in the last half millennium. In language suitably abrasive to capture attention and to stimulate debate, the Poona Indictment argues that modern science:

> . . grew in the cultural milieu of the West which put Man at the centre of creation and exhorted him to use knowledge to enhance his power. Science, thus, became an instrument of 'mastery' over both nature and the cosmic order and, together with its progeny, modern technology, became the purveyor of imperial expansion, the instrument of ravaging and of manipulation of resources and the environment, of racism, of modern militarism, of fascism, and of authoritarian socialism.[9]

With the enormous power generated by modern science and technology, Western culture acquired an expansionist thrust of exponentially increased dimensions. This expansionist thrust undermined the autonomy of various Third World societies, destroying their economies and systems of production and turning them into vast hinterlands of commodity suppliers for what today is called the advanced industrialized societies.

This historical process also spawned a myth that Western technology was inherently superior to the indigenous technologies of the Third World. This myth soon became embedded in, and was sustained by, Western scholarship in the history of science and technology. The basic premise of this body of scholarship was and is that modern science and technology radiated outward from metropolitan centers in Europe and later North America, bringing light to, and alleviating the misery of, unwashed, unenlightened natives of the non-Western world. There was even a hint of racism in the contention that only Western societies were truly capable of mastering

[9] 'The Perversion of Science and Technology: An Indictment' (Poona Indictment), *Alternatives, IV*, 3 Special Issue on Science and Technology, January 1979, pp. 413–416.

modern science and creating modern technology; Japan, as the first non-Western nation to make it into the charmed circle, is the aberration which proves the rule.

Nowhere has this myth of Western scholarship, and the underlying social reality it professed to represent, been more forcefully challenged than in Claude Alvares' major new work.[10] Alvares demonstrates with extensive evidence how much more productive and advanced the technologies in China and India were before they were displaced, often brutally, by Western technologies and productive activities which became dominant in the wake of colonialization. Much of this evidence has been long submerged, if not suppressed, because it did not conform to the dominant paradigm of Western scholarship.

But what occurred during the period of historical colonialism is a pale shadow of the process of penetration and destruction of indigenous technologies and patterns of self-sustaining livelihood, which industrialized countries use in the Third World today. This process of 'de-industrialization', a shorthand expression for destruction of the capacity to maintain, and the potential to increase, the productivity of people wrought by alternative patterns of productive activity, is accelerating in poor countries. The mechanisms of acceleration include the growing scope of multinational corporation operations and the expansion of export-oriented modern industrial sectors in Third World economies. Both activities are based largely on imported capital and energy-intensive, environmentally destructive Western technology and both serve the insatiable appetites of affluent consumers in industrialized countries, often for socially trivial goods.[11]

> In fact, the neo-colonial phase, in which the penetration of transnational corporations makes physical occupation of territory unnecessary, has led to much greater control and ravaging of the Third World, and seduction of its elites into a global structure of power, privilege, and wealth. With the Third World political, bureaucratic, military, academic and communications elites accepting the superiority of Western-style 'modernization' and the role of science and technology in it, there has emerged a global system of control, hegemony, exploitation and repression - all in the name of modernity and the theory of progress, all in the name of science and technology.[12]

The social pathologies and environmental destruction visited upon industrialized societies through the instrumentalities of modern science and technology are no less serious. The 'civilization diseases', such as mental illness and cancer, are increasing in incidence as a consequence of psychological stress and environmental pollution. Technologies which require

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[10]Claude Alvares, *Homo Faber. Technology and Culture in China, India and the West, 1500 to the Present Day* (New Delhi: Allied, 1979).
[11]Claude Alvares, 'Development against People', *Development Forum*, July 1978.
[12]Poona Indictment (f.n.9), p. 414.

enormous capital investments and centralized systems of production and distribution, and which depend on built-in obsolescence and wasteful consumption of non-renewable resources, offer further indication of our present predicament. Vast expenditures are made for research on socially and environmentally destructive nuclear technology while virtually nothing is spent on the development of renewable sources of energy.[13]

Advocates of modern technology in an unbridled form would argue that only by using such technology has it been possible to achieve the extraordinary gains in labor productivity which have ended material deprivation and brought prosperity to millions of people. But as Richard Falk, Schumacher, and numerous others have demonstrated, the system of production utilizing this technology is not sustainable; the prosperity of Western man has been realized only by exploiting the resources and labor of others, and the social costs are now beginning to catch up with and outrun the benefits.[14]

The energy and environmental crises in industrialized societies are well documented and need no further elaboration here.[15] Less salient for Western public consciousness, because it has thus far primarily affected socially marginal groups such as racial and ethnic minorities, is the structural unemployment generated by modern capital-intensive, labour-saving technology, and the allied phenomenon of de-skilling workers. Nevertheless, destruction of meaningful and productive work, a problem already existing on a massive scale in the Third World, is about to burst upon the industrialized countries as well, particularly through the application of micro-electronic technology – a phenomenon discussed below.

All of this adds up to a first class equity crisis for both the North and the South in the 1980s, if it is not already upon us. Unemployment rates of 10–20%, shockingly high by prevailing standards in rich countries, are

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[13]These and other aspects of the adverse impact of modern science and technology on industrialized societies are further elaborated in the Poona Indictment (f.n. 9), especially pp. 414-415.

[14]See, for example, Richard Falk, *This Endangered Planet* (New York: Random House, 1971); E. F. Schumacher, *Small is Beautiful* (f.n.2).

[15]The literature on the energy and environmental crises in industrialized societies is vast, and includes works cited in the preceding note. See, merely by way of illustration, Barry Commoner, 'The Solar Transition', *The New Yorker*, 23 April, 1979, pp. 53–98, and 30 April, 1979, pp. 46-93, and the various writings of Amory Lovins on 'Soft Energy Paths', many of whose ideas are pulled together and summarized in a recent article, 'Safe Energy', *Resurgence*, January–February 1979, pp. 17–27. Those who think these crises have been solved or are well on their way to solution should ponder the growing evidence about the irreversibility of CO_2 accumulations in the atmosphere. For a survey and assessment of the scientific evidence, see a forthcoming study by the Natural Resources Defense Council on carbon dioxide concentrations in the atmosphere and their climatological effects.

now predicted for industrialized economies in the 1980s.[16] But the social dislocation that will be visited upon the North is a pale shadow of what already exists, let alone what lies ahead, for the South.

Recent estimates place up to 54% of India's rural population (and 40% of the entire population) below the poverty line – defined in one instance as the minimum number of calories sufficient to stay alive.[17] Income distribution is another manifestation of the equity crisis in the Third World. In the 1960s, while Brazil was aggressively importing capital-intensive, labor-saving technology from the North, the share of national income received by the top 5% of the population increased from 27% to 35% at least by official government statistics (private estimates place the share as high as 46%).[18]

Another manifestation of the equity crisis is unemployment, underemployment, and employment at very marginal levels of productivity, already at depressingly high levels throughout the Third World. From 1961 to 1971, to use India again as an illustration, the number of landless and almost landless laborers, for whom these conditions were particularly acute, increased by 90%. But what lies ahead is far worse. From 1974 to 1984, the male labor force alone will grow from 152 million to 196 million.[19] Meanwhile, in the much-vaunted, buoyant modern industrial sector of the Indian economy – which, according to prevailing paradigms of 'development planning', is supposed to provide the way out of India's massive equity problems – private sector employment has essentially stagnated during the past decade, hovering between 6·5 and 6·8 million workers from 1965 to 1976.[20]

Given these undesirable outcomes, it is reasonable to question the extent to which even revolutionary technological change (such as will be examined below) can bring about the type of radical social change which is necessary to realize the goals of millennial transition. The answer is clearly, No. In and of itself and in isolation from other economic, social, and political

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[16]Ray Curnow, 'The Future with Microelectronics', *New Scientist*, 26 April, 1979. The article draws on a recently published study by Curnow and Iann Barron, *The Future with Microelectronics* (London: Frances Pinter Ltd., 1979).

[17]Pranab K. Bardhan, 'The Pattern of Income Distribution in India: A Review', *Sankhya The Indian Journal of Statistics 36*, Series C, Parts 2 and 4, 1974, pp. 103-138; and V. M. Dandekar and N. Rath, *Poverty in India* (Poona: Indian School of Political Economy, 1971).

[18]James H. Weaver, Kenneth P. Jameson, and Richard N. Blue, 'A Critical Analysis of Approaches to Growth and Equity', (Paper prepared for International Studies Association Annual Meeting, 17–20 March, 1977, St. Louis).

[19]K.N. Raj, 'The Economic Situation', *Economic and Political Weekly*, 3 July, 1976, p. 995.

[20]Employment figures are taken from the Government of India, Ministry of Finance, *Economic Survey: 1976* (Delhi: Publications Division, 1978). Even if public sector industrial employment is included and adjustments are made for nationalization of key industries (e.g., coal, banking) during this period, the picture does not change markedly.

changes, technology is not capable of spawning radical social changes On the other hand, it may be a factor in the acceleration of certain social, economic, and political changes which lead to social and environmental deterioration – e.g., to the alliterative crises of the 1980s. To the extent that such deterioration may create the possibility for radical social change, new technologies (or renewed use of 'old' or indigenous technologies) may facilitate the emergence of new kinds of social arrangements and productive activities that are more compatible with the world order goals of peace, economic well-being, social justice, and ecological balance. These 'transitional technologies', as I call them, can be considered leverage points in the process of achieving millennial goals. This point is important and warrants further discussion.

Transitional technologies as leverage points in social change

In considering the potential role of technology in the millennial transition, it is important to establish technology as a variable in the process of social change. In special cases, such as in the field of advanced military technology, if one of the superpowers learns to build a more destructive weapons system, it is likely to produce it in order to maintain its presumed advantage or to overcome the perceived advantage of the principal adversary. Thus military R&D becomes a significant factor in propelling the arms race and tends to operate as an independent variable. But for the most part it is clear that technology is a dependent variable in the process of social change.

To overstate the case in order to make the point, let me present some well-chosen observations by Luis de Sebastian, of the Central American University in San Salvador, concerning the irrelevance of so-called appropriate technology for the Third World:

> ...it becomes obvious that the technology to be found in the developing countries is, in general, appropriate for the rich and powerful but highly inappropriate for the poor who constitute the majority.... If we accept that the technology now installed in the developing countries is appropriate to the national and international groups which rule their economies, we cannot hold great hopes for technological change, either through an autonomous development process or through the transfer of technology. We must ask ourselves where the initiative for a technological change is going to come from if those who control the economy do not feel the need for it.[21]

[21] Luis de Sebastian, 'Appropriate Technology in Developing Countries: Some Political and Economic Considerations', in Jairam Ramesh and Charles Weiss (eds.), *Mobilizing Technology for World Development* (New York and Washington: Praeger Publishers, International Institute for Environment and Development, and Overseas Development Council, 1979), p. 68.

Technology is clearly a dependent variable in the process of social change, and Father Sebastian, a University of Chicago-trained economist, is certainly right that technology alone is not the engine propelling the vehicle of social change. On the other hand, many economists, neo-classical or otherwise, underestimate the interactive character of technological and social change. This is not the place to go into 'long wave' theories of world economic development or the ideas of Joseph Schumpeter and other economists about the significance of invention in economic growth. In several recent papers, Christopher Freeman of the Science Policy Research Unit at the University of Sussex has done this more authoritatively than I can.[22] Suffice it to say that I find myself closer to the position of Freeman who, while far from being a technological determinist, concludes that most economists have underestimated the significance of technical change for economic change.

If we broaden the context of the discussion to encompass political power, it seems to me that the case for an interactive relationship between technological and social change becomes even stronger. Technological innovation may create new options or instrumentalities for those in positions of power to extend or increase their power. Nuclear technology, both military and non-military, in the postwar era is a good case in point. Technology can also be a factor facilitating change. Military nuclear proliferation, one element moving the world political system away from its bipolar character at the end of the Second World War towards its present multipolarity, is another case in point.

While the 'transitional technologies' mentioned above and described below can be instruments to facilitate beneficial social change, we should not delude ourselves. Transitional technologies can also become new and more efficient means of repression and exploitation. One critical question is always: who controls the technologies? Another critical question, one we explore below, concerns the balance between large and small, capital-intensive and labor-intensive, centralized, and decentralized, 'advanced' and 'traditional' technologies. The notion that these categories are inherently in conflict and mutually exclusive is false, as John and Nancy Todd of the New Alchemy Institute have demonstrated in their latest book. There they argue that micro-electronics and other 'advanced' technologies offer new opportunities for developing and disseminating environmentally sound, energy-conserving technologies leading to greater social autonomy and

[22]See, for example, C. Freeman, 'Technology and Employment: Long Waves in Technical Change and Economic Development' (Holst Memorial Lecture, December 1978).

equity.[23] But no one, least of all the Todds, would argue that technological changes like those occurring in micro-electronic and bio-technology are 'the' answer to coping with the alliterative crises of the 1980s, let alone realizing the goals of the millennial transition. Indeed, it is only by combining the 'old' and the 'new' guided by commitment to social justice, and carried out within the context of a more equitable economic and political order, that these goals will be achieved. At various points in the remaining discussion, and particularly in the section on transitional strategies, I shall suggest some steps leading to a broadened base of control over the selection and development of transitional technologies.

A. Micro-electronic and materials technologies: coming revolutions?

The genie of revolutionary technological change is already head and shoulders out of the bottle as we enter the last two decades of the twentieth century. This genie is the revolution in micro-electronic technology now beginning to hit the economies of the industrialized countries. When it strikes these economies with full force, it will radically alter the global political economy, affecting Third World countries as well.[24]

History tells us that bottling up technological genii is extraordinarily difficult, if not impossible. How and when the genie gets the rest of the way out will depend on a variety of economic and political rather than technical factors. Technologically, the genie is already sufficiently well formed to assure profound economic, social, and political conflict as it emerges from the bottle.

Because the micro-electronic genie is not yet fully exposed, we know all too little about its actual social consequences. Research into this vitally important issue is still very limited, and conclusions are necessarily tentative. But certain basic trends are already apparent in both industrialized and developing countries.

If the micro-electronic revolution continues at the present pace, these trends will become sharply accentuated by the middle to the end of the 1980s. Of course, such an observation about the social impact of technology is always subject to the qualification that political and economic factors, having created the conditions which led to the creation of the genie in the first place, can sharply alter its consequences for society as well.

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[23]John and Nancy Todd, *Tomorrow Is Our Permanent Address* (New York: Harper and Row, 1980).

[24]This section is adapted from my 'The Micro-Electronic Revolution and North-South Relations: Letting the Genie Out of the Bottle?', *Development Forum*, September 1979.

More speculative is a second revolution in materials technology apparently not much farther down the road. Some would indeed argue that, because of the impact of growing shortages and rising prices of non-renewable natural resources (especially for energy) the revolution in materials technology may not be so far off.[25] The solar transition, in this view, is under way. Enzyme engineering, another example, appears to be on the threshold of a major breakthrough, with developments in other areas of biotechnology not far behind.

Equally notable, perhaps more so in terms of its implications for social autonomy and equity, is work being done at institutions like the New Alchemy Institute in Woods Hole, Massachusetts, on bio-technology. Investigations of small-scale biological systems which are virtually self-sustaining in terms of energy inputs are especially important because these systems can be replicated on a wide scale by persons with only modest levels of technical skill. These systems point the way to sustaining large human populations using ecologically viable methods embodied in small and intermediate technologies. Furthermore, they offer a basis for achieving an 'economics of permanence'. It is also interesting to note that sophisticated techniques based on advances in micro-electronics, including computer modeling and electronically operated control systems, have been used to develop some of these systems.[26]

But the revolution in micro-electronics is closest at hand and should be at the center of international debate on the future of the global political economy. What is striking is its absence from that debate, at least thus far.[27] The UN Conference on Science and Technology for Development (UNCSTED), held in August 1979, in Vienna, provides a good illustration. In Preparations for the Conference, the issue of technological trends in developed countries and their likely impact on developing countries was given only the most marginal attention.

We are on the threshold of radical change in the manner in which goods and services are produced, distributed, and information managed and disseminated through micro-electronic technology. The key to these radical changes lies in dramatic reductions over the past 20 years in cost and corresponding increases in computing power, measured in terms of components per silicon chip used in integrated circuits in computers and other electronic devices.

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[25]See, for example, Commoner and Lovins (both in f.n.15)

[26]Letter from Nancy Todd, New Alchemy Institute, 20 October, 1979.

[27]See, for example, 'Will Technical Change Make UNCSTED Irrelevant?', and 'UNCSTED Misses the Boat: North-South Trade, Employment and the Technology Revolution of the 1980s', *Lund Letter on Science, Technology and Basic Human Needs*, June 1979, Letter No. 13.

As costs fall and capacity increases, the range of application of micro-electronic technology widens enormously – from aerospace to industrial electronics, television, calculators, watches, automobiles, telecommunications, typewriters and robotics.[28] Many of the functions now being performed by human beings in manufacturing and service sectors of industrialized economies can be performed faster, cheaper, and more reliably by micro-electronic devices or by machines controlled by these devices. Micro-electronics offers not only cost reduction and speed, but promises flexibility, reliability, maintainability. It also has the capacity for self-diagnosis, correction and linkage to information hierarchies.[29]

All these factors make it possible to improve efficiency in use of raw materials and energy and to increase, sometimes dramatically, the productivity of labor and, at least potentially, of capital. While micro-electronics is already having a substantial impact on employment in some manufacturing sectors (see Table 2), it is expected to have far greater impact on the information sector and on the principal occupational groups in that sector – secretaries, clerks, typists, supervisors, and even middle-level managers. Thus one forecast for the French banking industry estimates that while the industry will continue to expand in the 1980s, employment will decline 30% by 1990.[30]

Table 2*

Impact of Micro-electronics on Manufacturing employment in industrialized economies: some illustrative data

— In West Germany, 35 000 jobs have been lost in the printing industry since 1972.
— Employment in the telecommunications industry in the United Kingdom dropped 30% from 1974 to 1979 while a major US manufacturer cut its work force by more than half from 39 200 to 19 000 in six years (1970–1976).
— Workers producing cash registers for a large North American firm declined from 37 000 in 1970 to 18 000 in 1975. Corresponding figures for a British firm show a drop from 2000 to 1300 in a single year.
— A Swedish manufacturer of telephone exchanges reduced its workers from 15 000 to 10 000 from 1975 to 1979.
— In a West German factory making teleprinters, employment fell from 1800 to 800 in two years as micro-electronic technology was introduced.

*Source: Data from John Bessant, Technology Policy Unit, University of Aston, Birmingham (drawing in some instances on data from TPU colleagues).

[28]Derek Roberts, 'Chips – Challenges and Opportunities', *New Scientist*, 8 June, 1978.
[29]Keith Dickson and John Marsh, *The Micro-Electronics Revolution: A Brief Assessment of the Industrial Impact with a Selected Bibliography* (Birmingham: University of Aston, Technology Policy Unit, Occasional Paper, December 1978). See also the work of John Bessant, also of TPV at Aston, and Raphael Kaplinsky.
[30]S. Nora, *L'Informatisation de la Societe*, published by *Documentation Francaise*, 19 May, 1978, as cited in Dickson and Marsh (f.n. 29).

Since the information occupations now constitute the largest single category in the work force of most industrialized countries, as typified by US, (see figure 1) even moderate improvements in productivity could have quite startling impact on employment over a short period of time. Employment levels of 10–20% by the mid–1980s are by no means out of the question.[31]

Some observers of these technological changes point out that there are many unresolved problems in the application of micro–electronics, especially in soft–ware development. They also point out that cost reductions may not be so dramatic. In any event, experience in the past 30 years demonstrates that industrialized economies have a considerable capacity to create new jobs to absorb people displaced by changes in technology.[32]

But even such a careful student of technological impact on employment as Christopher Freeman concludes that 'in the race between job–generating investment and job–displacing technical change, I would expect job displacement to draw ahead in the 1980s.'[33] A former member of the Science Policy Research Unit at Sussex who has just completed a major study of the information sector in the British economy, Ray Curnow, says of the economic and social impact of micro–electronics, 'the overall consequences are comparable with the industrial revolution.'[34]

Whatever may be the magnitude and character of labor displacement from technological change in industrialized countries, it pales to the point of insignificance when compared to the problem of providing meaningful and productive work for people in Third World countries. Already confronted with high unemployment and underemployment, these countries, as we have suggested, are headed for a major equity crisis in the 1980s with a rapidly growing work force, widespread poverty, and badly skewed income distribution.

Developing countries are confronted with a Hobson's choice in devising strategies to provide productive work for their peoples. Completely implausible increases in jobs would be required to absorb current and future population growth through expansion of industrial employment. To do this in India, a 22·1% *annual* increase in industrial employment would

[31]Curnow (f.n.16), p. 254.

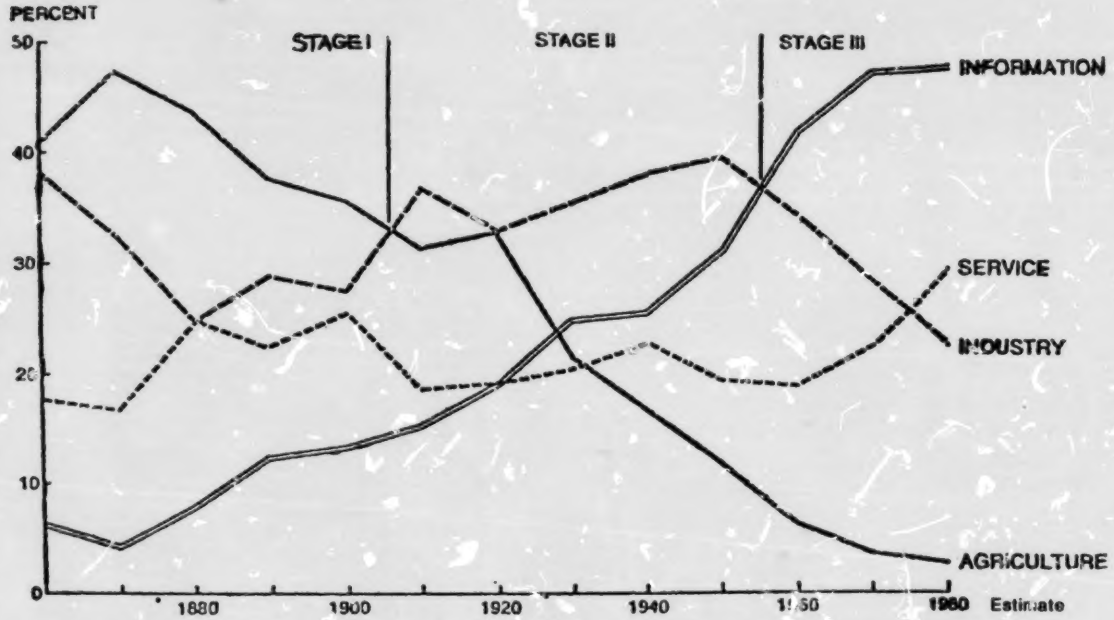
[32]Much of the problem of technological unemployment in this view can be solved simply by shortening the work week. An economist of no less stature than Nobel Laureate Wassily Leontieff has recently taken this position (see his 'Newer and Newer and Newer Technology with Little Unemployment', *New York Times*, 6 March, 1979).

[33]Freeman (f.n.22), p. 19.

[34]Curnow (f.n.16), p. 254.

Figure 1

Changing sectoral character of US work force



Source: M.U. Porat, *The Information Economy*, Washington: US Department of Commerce, Office of Telecommunications Special Publication (Vol. XXX 77-12-1), May 1977. (Figure is based on US Census Bureau and US Bureau of Labor Statistics data).

be required; for Brazil, the necessary increase would be 16·2%.[35] In fact, as we have noted, employment in the private industrial sector in India has virtually stagnated during the past decade, hovering between 6·2 and 6·5 million.

The Hobson's choice becomes even more glum if the labor-absorption possibilities of agriculture are considered. Under the most favorable cropping and technology mix for employment generation, it is estimated that as much as 50% of the rural population in India would have to find some form of non-farm employment.[36] While so-called appropriate technology can help at the margins, it is no solution to the huge problem confronting the Third World of generating work. In fact, overemphasis on labor-intensive technology could entrap poor countries due to problems of low productivity, rendering efforts to meet essential material needs and to provide productive work for their populations even more difficult.

If appropriate technology is not the total solution to Third World employment problems, common sense compels us to question the relevance of micro-electronics – a form of modern technology which dramatically increases labor productivity. For a curious set of partly perverse reasons, micro-electronic technology does have a potentially significant role in helping poor societies grapple with their equity problems. It may also help them achieve a more autonomous, less dependent role in the international system.[37]

First and foremost is the promise micro-electronic technology holds for significant gains in the productivity of *both* capital and labor. All other things being equal, it is certainly an advantage to capital-poor developing countries to obtain greater output per unit of capital invested. Other characteristics of micro-electronic technology are also relevant to developing economies – for example, its relative flexibility and the possibilities it offers for greater product differentiation. In principle this means that developing countries can adapt existing technologies more easily to their own social requirements or raw material availabilities. In a similar vein, possibilities

[35]Staffan Jacobsson, 'Trends in Manufacturing Output and Employment in LDCs and DCs'. Background Paper prepared for Lund Workshop on Technological Change in Industrialized Countries and Its Consequences for Developing and Industrialized Societies. May 1979.

[36]Pramit Chaudhuri, 'Labour-Absorption Possibilities in Indian Agriculture: A Brief Report', Presentation to Lund Workshop and background paper for the workshop, May, 1979.

[37]I recognize that these assertions will tax the indulgence of most readers. It should be understood that the case is partly speculative because of the embryonic state of our present knowledge of the economic, social, and political consequences of widespread adoption of micro-electronic technology.

for decentralization of production may enhance development of small-scale, high-productivity industrial enterprises which are physically dispersed and close to consumers, thus diminishing transportation costs and urban concentrations.

It is clear, of course, that industrialized societies will capture the benefits of micro-electronic technology more readily because they already have communications, transportation, and technical education infrastructures. The economic and political realities of developing countries cannot be ignored, and the circumstances under which it will make sense to use micro-electronic technology will differ greatly from the industrialized countries. In fact, there is a danger that economic and political decision-makers in the Third World, effectively seduced by hardware and software salesmen from the North, will become infatuated with this new technology and seek its indiscriminate application.[38]

Thus far, we have been proceeding as though micro-electronic technology, economically beneficial even though socially disruptive, is politically benign. Nothing could be further from reality. Certain applications of micro-electronics offer the distressing means by which the effectiveness of technologies of destruction and control can be enhanced. Therefore, the question of who among, as well as within, countries controls critical elements in this technological revolution becomes critical.

Because there is no known way of getting this technological genie back in the bottle, wholly or selectively (like nuclear weapons technology by trying to quarantine certain presumptively less 'reliable' and 'politically stable' nations of the Third World), the best strategy for minimizing possibilities of exploitation and control is to diffuse micro-electronics through as many channels as possible. This is an important reason for Third World countries (and for institutions in those countries responsive to the unmet needs of the poor majorities) to get in on the micro-electronic act. Failure to do so will cast them in a more dependent relationship with the First and Second Worlds during the millennial transition. The industrialized countries will find it all the more tempting to use the advantages of micro-electronic technology – in terms of speed, flexibility, cost, reliability, and control – to maintain their dominant position in the international economic and political system. They will sell the products made possible by micro-electronic technology and their services in applying that technology abroad at inflated prices, unless Third World countries develop basic competence in using and

[38]In fact, standard economic analysis, which I often distrust because of its insensitivity to non-monetizable social and political considerations, may be a pretty good guide to the circumstances under which it would make sense to use micro-electronic technology in the Third World.

understanding this rapidly changing arena of technology and become effective bargainers.

One reason for the Third World's adoption of micro-electronic technology is *not* to gain or enlarge their access to markets of industrialized countries. Again and again the cry from Southern spokesmen for the New International Economic Order (and from Northern spokesmen who say they wish the South well, a recent example being Robert McNamara of the World Bank at UNCTAD V in Manila in May, 1979) illustrates their concern that if the South is going to find a way out of the poverty and deprivation which afflicts their peoples, the North must open its markets to Southern manufactured goods.[39] There are two things wrong with this cry: it is not going to be heard, and even if it were, it would not provide a 'way out' of poverty and deprivation.

For most Third World countries, certainly the larger ones with most of the world's poor like Brazil, India and China, a buoyant export-oriented industrial sector aimed at penetrating industrialized markets with its output, no matter how dynamic, will not solve the employment and equity problems in these economies. In fact, substantial evidence suggests that this kind of export-led strategy of national economic development aggravates those problems by unduly concentrating scarce capital resources in the modern sector and by diverting productive energies and raw materials from meeting the needs of local populations in the deprived rural sector.[40]

The second thing wrong with this cry is that it is not going to be heard. By the time the full brunt of the micro-electronic revolution hits Northern economies, they will be far more protectionist than they are now, striving to save every job they can from 'cheap labor' competition through imports.

Even if Northern economies do not become more protectionist, micro-electronic technology, with the dramatic increases in labor productivity it promises, will erode the comparative advantage of Third World countries in more labor-intensive production. A major European electronics manufacturer is thus said to have concluded that it is more profit-maximizing and risk-minimizing to build automated electronic factories in Europe in the future than it is to continue labor-intensive manufacturing in Asia. And with automated looms, some European textiles are again cost-competitive with those made in the Third World.

In any event, expectations in developing countries about industrialized country markets have already reached totally unrealistic levels. If all the

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[39]Robert S. McNamara, Address to the United Nations Conference on Trade and Development (Manila: 10 May, 1979), Washington: World Bank, May 1979.

[40]This thesis has been developed by Claude Alvares in 'Development against People' (f.n.11).

shoe manufacturers in Asia were actually to attain their projected levels of exports to Europe by 1980, European domestic shoe production would have to stop completely and per capita shoe consumption would have to increase exponentially.[41]

These trends and forces are likely to add up to less, rather than more, economic integration of the North and the South in the remaining decades of this century, a theme to which we shall return. Thrown increasingly on their own resources and initiative, Southern countries may well expand already existing trade, investment, and technology links among themselves. Whether a less exploitative international system will result remains to be seen, but even weaker Third World countries may be no worse off than they are in highly dependent relationships with industrialized countries. In fact, if adroit, they may be able to play off different groups of dominant actors from both the North and the South against one another.

For no group of countries in the modern world is the promise of extraordinary gains in productivity and of efficient use of raw materials through micro-electronic technology more important than it is for the Third World countries. Unless they can increase productivity dramatically and use their resources more efficiently, there is no way out of the poverty which engulfs them. For these countries, the micro-electronic revolution offers the promise of a more autonomous, less dependent role in the global political economy. Social equity within these countries may be no greater if micro-electronic technology is used, but it may also be no worse than it is now. As for Northern countries, use of these technologies offers the possibility of a somewhat more distant but less exploitative relationship with the South.

But for both groups of countries, the critical problems are economic and political – in a word, who controls, who benefits, and who pays. It would be naive in the extreme to think that the task of distributing the productivity gains of this technological revolution will be easily or equitably solved as long as control over development and use of micro-technology is concentrated in a handful of powerful corporate and other dominant political and economic institutions.

Since there is no practical way of getting technological genii back in their bottles, we had best get them all the way out. These new technologies are less likely to be used in perpetuating exploitation and inequality to the

[41]Raphael Kaplinsky, Presentation to the Lund Workshop and 'The Impact of Micro-electronic Related Innovations on UDC-DC Trade', Notes prepared for the Lund Workshop on Technological Change in Industrialized Countries and Its Consequences for Developing and Industrialized Societies, May 1979. These figures are subject to the criticism that they are only planning projections and not realistic targets for production. But they nonetheless illustrate, by a general order of magnitude, the problem of unrealistically heightened expectations.

extent that access to them is made as open as possible on a global scale. If this is achieved, micro-electronic technology can play an important role in the millennial transition to a more just, peaceful, equitable, ecologically sustainable world.[42]

B. Indigenous technologies in the millennial transition: old wine in new bottles

As shorthand ways of identifying more complex phenomena, labels become important when they convey certain characteristics about the phenomena to which they are applied and exclude others. For this reason, I have resisted the more conventional label of 'traditional technology' for technologies indigenous to Third World societies – those which constitute the technological 'mainstream' and represent the accumulation of knowledge and skills used by 75–85% of the people in their daily lives. 'Indigenous technologies' does not, however, refer to alien technologies which have been adopted, sometimes adapted, and even occasionally generated within Third World countries but which are based on similar Western technologies (even though, they are often described as indigenous technologies). Rather, I have in mind technologies which have been internalized in the sense that they have demonstrated their compatibility with the cultural values, social institutions, and ecological balance within Third World societies.

As Ashis Nandy reminds us, the use of labels such as 'traditional' and 'modern' technology helps sustain the myth that 'modern' technology is superior to other forms of technology. In addition, it overlooks the fact that 'modern' technology is itself simply another variation of traditional technology which emerged in one quadrant of the globe in the last 200 years. To quote Nandy,

> It is becoming obvious even to the layman that modernity is only a secularized euphemism for Westernness and certain dominant strands of consciousness within the Judeo-Christian tradition. Seen as an idea of technology, it is just another form of tradition, presently dominant on a global scale because of the inequitous distribution of political and economic power in the world. It is this *tradition of modernity* which the present scientific and technological world-views have been trying to fob off on the rest of the world with the help of the doctrine of progress *a la* Vico, Hegel, and Marx on the one hand, and Locke, Hobbes, Bentham and Mills on the other. In reality, *the choice is not between traditional and modern technologies; it is between different traditions of technology*, some dominant and

[42] I do not mean that I applaud and support indiscriminate technological change which can, and has, led to greater and greater social and environmental destructiveness but, rather, that my perception of the economic and political realities of the millennial transition leads me to conclude that these technological revolutions will occur. The critical task becomes one of shaping and using them along more humane, less exploitative lines.

some recessive, some appropriate and some inappropriate, some endogenous and some exogenous.[43]

Likewise, I resist the label of 'alternative technology,' and I am again indebted to Ashis Nandy for the buttressing argument:

..the very concept of traditional technology has come to mean, at least in most of the Third World countries, a compromise with a less modern technology and a shift to alternatives for reasons of capital scarcity, energy crisis, or attempts to move away from an elitist, large-system-dominated model to a village-centred political economy oriented to the rural poor. This is patently absurd.[44]

If technologies are to be judged in terms of their harmony with social and physical environments, then indigenous technologies are neither marginal nor 'scientifically flawed'. They are mainstream, not alternative, technologies which, Nandy goes on to argue, 'modern Western technology is trying to supplant in the name of a doctrine of progress which is not only marginalizing but also irrelevant to the life-styles of the majority'.[45]

Relevance to life-styles and to harmony with social and physical environments – the 'economics of permanence', to use Schumacher's phrase (to which should be added the 'ecology of permanence') – is the hallmark of indigenous technologies. The suitability of specific indigenous techniques is determined, not in isolation from other considerations, but within the framework of the overall rationality and functioning of the social order and its cultural ambience. These are technologies, not for maximization of profit, but for survival. As Claude Alvares observes,

Fully half the population of today's world are survival technicians; they do not exploit the Western technological system. They are craftsmen of necessity, and that necessity is in a very real sense rationally engaged.

For a survival technology only makes sense if viewed in the context of a *survival algorithm:* a set of rules of farming, for instance, that ensures a tolerable minimum output.[46]

One of the most important initiatives in translating these abstractions about indigenous technologies into concrete terms is the compilation of the Great Village Catalogue by Alvares, his associates in the Rural Study and

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[43]Ashis Nandy, 'The Traditions of Technology' in Ward Morehouse (ed.), *Science, Technology and the Social Order* (New Brunswick, New Jersey: Transaction Books, 1979), reprint of *Alternatives iv, 3,* Special Issue on Perversion of Science and Technology, January 1979, p. 382 (emphasis original).

[44]ibid., p. 384.

[45]ibid., p. 384.

[46]Claude Alvares (f.n.10), pp. 16–17; 'The Great Village Catalogue and Its Implication for Alternative Technology', Paper prepared for World Order Models Project workshop on technology, Falmouth, Massachusetts, June, 1979, pp. 1–2. Related in character is a United Nations University project on sharing traditional technologies being organized by Chandra Soysa of the Marga Institute in Sri Lanka.

Transformation Centre (RUSTIC) which he has set up in Goa, Kartikheya Sarabhai and his colleagues at the Vikram Sarabhai Centre for Development Action in Ahmedabad, and a variety of other individuals and institutions in India and elsewhere in the Third World. In Alvares' own words:

> The GVC essentially is about how rural people build their houses without architects, how they operate agricultural and aquacultural systems based on centuries of gradually accumulated research, how they heal themselves with indigenous medical remedies, how they produce goods for income or exchange, how they use energy, how and what they eat and dress, how they communicate, and so on.
>
> Unlike other catalogues on the rural scene, this one has no development bias. We are interested first of all in how rural people manage on their own. Thirty years after independence most rural people still have to depend on their own ingenuity to survive. The time has come, in fact, to explode the legend that the villages of the Third World are stagnating human environments, and that if anything happens there, it is basically the result of interventions or projects initiated by 'development' workers, university radicals or peaceable Gandhians. The creativity of the rural mind in meeting its most serious problems (and these include the barbarous attacks by high caste landlords) is quite astonishing. The work done through urban initiatives is quite insignificant by comparison.[47]

Rural environments within which indigenous technologies predominate are not idyllic, as Alvares and others involved in the systematic examination of such technologies are well aware. The negative aspects of Third World rural life are strikingly similar to those of life in modern industrialized societies. While there is little alienation as such, there is a great deal of drudgery and monotony which, in a sense, is the rural Third World counterpart to alienation in industrialized societies. Technology is a social instrument for extracting labor from the workers and for generating profits and convenience for those who control the resources for productive activity, especially the land. Again, this is not unlike the role of technology in industrialized societies with production systems characterized by large, highly centralized corporate and bureaucratic structures.

Much of the deprivation and exploitation which exists today in the rural Third World has been exacerbated by the penetration of Western or so-called modern technology through economic and political instrumentalities, whether this technology is manipulated directly or by the hand of Third World elites in unholy alliance with their First and Second World counterparts (this is the phenomenon of 'de-industrialization' to which I have already referred). Deprivation and exploitation are often attributed to the presumed shortcomings of indigenous technologies. But a majority of the Third World continues to live by what Alvares calls 'survival technology, a technology that minimizes risk and promises faithful returns year in and year out'. This technology is based on an 'astounding versatility of skills', although Alvares

[47]Alvares, 'Great Village Catalogue', (f.n.46), p. 6.

does not claim that it always epitomizes use of local resources. It is possible to demonstrate that indigenous technologies in agriculture and other fields can be brought to a higher level of optimal efficiency by the application of modern science and technology. But, Alvares argues, 'there is no need to destroy it or displace it'.[48]

Indeed, the first operational task of the millennial transition may be to stop the wholesale destruction and displacement of indigenous technologies and thereby retain the livelihoods and life-styles these indigenous technologies sustain in the Third World. This process is graphically portrayed by Alvares in his account of the assault of multinational corporations and their local handmaidens on the resources and people of the Goan countryside in another work.[49] But the role of indigenous technologies in the millennial transition is much more important than a simple struggle for their survival suggests. There are striking similarities between the millennial dreams for post-industrial societies offered by social thinkers such as James Robertson, Hazel Henderson, or Bart van Steenbergen and the villages of the Third World which survive largely on the utilization of indigenous technologies.[50] Third World villages, at least those most independent of technological elements from the modern industrial system, are largely self-reliant, decentralized communities. Labor-intensive productive activities predominate, environmental pollution is virtually unknown, and the community produces mostly according to need, not greed.

In other words, Third World rural communities based on indigenous technologies are living representations of many of the qualities of life which should emerge for the rest of humanity during the millennial transition if the goals of peace, equity, and environmental balance are to be achieved in the twenty-first century. Indigenous technologies and the social institutions and values in which they are embedded need, therefore, to be preserved for the good of those who already possess them so that they will not have to be recreated in the next millennium. But these technologies must also be studied with care and sensitivity for the lessons they may hold for the rest of humanity struggling to achieve millennial goals.

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[48]ibid., pp. 6–7.

[49]Claude Alvares, 'Goa: Finished in Ten Years', *Inside/Outside: The Indian Design Magazine* (Bombay, 1979).

[50]See, e.g., James Robertson, *The Sane Alternative* (London: The Author, 1978); Hazel Henderson and Bart van Steenbergen, *'Creating Alternative Futures: The End of Economics'* (unpublished paper).

Disengagement in the millennial transition

The foregoing discussion underscores the need for *selective* Southern disengagement economically and politically from the North during the millennial transition. Maintaining open intellectual contact, however, is important but only on a more autonomous basis than has characterized much of the intellectual interaction between the North and the South during the postwar decades. The case for delinking has nowhere been more forcefully stated than by the Jamaica-born, Princeton-based economist, Sir W. Arthur Lewis:

> The fact is that the LDCs should not have to be producing primarily for developed country markets. In the first place, they could trade more with each other, and be less dependent on the developed countries for trade. The LDCs have within themselves all that is required for growth. They have surpluses of fuel and of the principal minerals. They have enough land to feed themselves if they cultivate it properly. They are capable of learning the skills of manufacturing and of saving the capital required for modernization. Their development does not in the long run depend on the existence of the developed countries, and *their potential for growth would be unaffected even if all the developed countries were to sink under the sea*....[51]

Lewis notwithstanding, global interdependence is, of course, a fact of late twentieth-century life. We are all indeed riders on Spaceship Earth – but, alas, a small proportion of humanity travels first class and the rest are down in steerage. Melancholy evidence accumulates that the 'benefits' from North-South economic and political interaction and other forms of international cooperation flow unevenly both within and between countries. This is hardly surprising, since the rules of the game have been set by the more powerful actors in the international system.

Efforts to maximize Southern penetration of Northern markets are likely to compromise Southern attempts to achieve a more autonomous and less dependent role in the international system. In addition, the displacement and destruction of productive activity which indigenous technologies provide may be accelerated in the process. The export-oriented modern industrial sectors of Third World economies will continue to be dependent on technology from the industrialized countries because typically these countries are the only source of economically competitive technologies – that is,

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[51] W. Arthur Lewis, *The Evolution of the International Economic Order* (Princeton: University Press, 1978), p. 71 (emphasis added). For a forceful statement of disengagement and its implications for Third World political, cultural and intellectual, as well as economic autonomy, see Rajni Kothari, *Footsteps in the Future: Diagnosis of the Present World and a Design for an Alternative: Pre-Worlds for the 1990s Series* (Institute for World Order, New Delhi: Orient Longman, 1974); as well as his Dyson Memorial Lecture delivered in Australia about the same time *Footsteps* was published.

technologies that aid in production of what industrialized countries' consumers will buy. The increasingly interlocking but still dependent relationship between the North and the South will expose Southern countries on a continuing basis to Northern pressure, by setting political and economic conditions as the price of continued access to those markets. Weaker Southern political economies will find it hard to resist this pressure in any show of strength against their Northern adversaries.

This is not the interdependence that Northern advocates of such a relationship would have us believe. True interdependence requires two roughly equal partners. This is simply a more intimate pattern of the prevailing dominance-dependence relationship which now characterizes the global political economy, a conclusion strikingly demonstrated by Graciela Chichilnisky,[52] Wassily Leontieff and others, and by the RIO group in the Netherlands headed by Jan Tinbergen.

In today's international political economy, Southern countries are generally regarded as having a good and increasingly substantial bargaining chip for use in controlling raw materials the industrialized countries need to maintain affluent living standards and to keep their economies functioning at a satisfactory level. There is no doubt about Northern dependence on the South, oil being the most obvious example; but this bargaining chip is likely to be short-lived and not nearly as potent as might otherwise be expected, especially if we examine trends in the global political economy in terms of decades rather than years. The revolution in materials technology, however, with its thrust toward renewable biomass resources, may be accelerated to the extent that Southern contries use their bargaining chip aggressively. There is little doubt that by inaugurating a price revolution in petroleum, beginning in 1973, OPEC has greatly accelerated progress toward the solar transition in Northern countries.

All this adds up to quite a different picture than is usually painted by strident Southern advocates of the New International Economic Order or by apologetic Northern well-wishers and supporters of NIEO. The millennial transition will move more surely toward the world order goals of the twenty-first century if the South delinks itself politically, economically and technologically from the dominant North. Selective delinking should be seen as a transitional strategy, leading to more autonomous relinking later, when local productive and problem-solving capacities are strengthened. It should not be dismissed by setting up the straw man of technological autarchy, obviously a foolish strategy in the modern world. Far from being radical and unthinkable, disengagement has solid historical antecedents; virtually

[52]Graciela Chichilnisky, *Basic Needs and the North-South Debate* (New York: Institute for World Order, WOMP Working Paper 17, 1981).

all of the rich countries went through periods of selective disengagement during their own period of economic and political development.[53]

But delinking will not necessarily achieve the world order goals of justice, peace, and ecological balance. It is important to emphasize the limitations and central characteristics of delinking, even at the risk of repetition, in order to keep it in proper perspective.

(1) It is a 'lesser evil' strategy. Disengagement can lead to more autocratic, exploitative, and uncontrolled use of power in 'delinked' Third World societies than in 'linked' ones. But (with marginal and numerical insignificant exceptions), linking Southern development to Northern political economies for the past 30 years has clearly not resulted in achievement of, or even in most cases progress toward, the millennial world order goals. In fact, many indicators suggest movement *away from these goals*.

(2) Disengagement is a relative, not absolute, condition. Complete delinking or autarchy is not possible in the contemporary world.

(3) It is a transitional strategy, leading to reengagement as societies become more autonomous and are able to relink with the international order in a less dependent manner.

(4) Selective delinking does strengthen technological autonomy and local problem-solving skills. No Southern country has moved very far in the direction of greater social equity on a self-sustaining basis (again with some possible marginal and atypical exceptions) without substantially increased technological autonomy.

(5) Far from being an "unthinkable" and impractical strategy, there is solid historical evidence for disengagement. Virtually all the industrially advanced countries at one time or another were selectively disengaged from the international system.[54]

Finally, the social and psychological costs to dominant parties in a linked

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[53]For historical cases of disengagement, see Dieter Senghaas's work, e.g., 'Dissociation as a Development Rationale,' paper prepared for International Workshop on Technological Dependence, Bonn, 2–5 November 1978. See also my 'Third World Disengagement and Collaboration : A Neglected Transitional Option' in Ramesh and Weiss (f.n.21), pp. 4–81, and my UNITAR Working Paper for argumentation of the contemporary delinking thesis; as well as the joint paper by David Chu and Ward Morehouse, *Third World Cooperation in Science and Technology for Development* (New York: UNITAR 1979), Science and Technology Working Paper Series, No. 5; and Carlos Diaz-Alejandro, 'Delinking North and South: Unshackled or Unhinged?', in Diaz-Alejandro *et al.*, *Rich and Poor Nations in the World Economy* (New York: McGraw-Hill, 1977).

[54]Dieter Senghaas; ibid.

but highly unequal relationship between societies must be recognized. Ashis Nandy has demonstrated how corrosive the colonial connection between Britain and India was of the colonizers' own professed social and political values.[55]

But is there, when all is said and done, an inherent contradiction between technological disengagement of the South from the North and Third World efforts to defend itself from the adverse consequences of new technologies (micro-electronic and biotechnology) emerging in the First and Second Worlds while at the same time exploiting opportunities raised by those technologies? This issue, as I see it, is one of struggle more than of contradiction.

It will certainly not be easy for Third World societies to gain access on their own terms to these new and rapidly changing technologies. The trick will be to achieve selective access under an autonomy-enhancing mode rather than utilizing the dependency-perpetuating mode characteristic of so much of the North-South technology transfer during the past 30 years. This will generally mean maintaining an arms-length relationship with the North and attempting, in a determined fashion, to acquire the capacity to recreate technology in the future on one's own. (In industry, this usually means developing a capital goods-producing capability.)

Technological delinking is not, I repeat, autarchy. Even at the height of the Cultural Revolution, the Chinese maintained a steady flow of technological intelligence from the industrially advanced countries. Current Chinese reengagement is certainly on more autonomous terms than many other Third World countries have achieved (although whether it will stay that way remains to be seen), in part because of enhanced local problem-solving capacities stimulated during earlier periods of disengagement.

There is, in short, no inherent irreconcilability between technological disengagement and Third World efforts to exploit new technologies emerging in the North. But the dominant modalities of North-South technology flows will certainly be different than they were in the past. Just how all this might be accomplished is the subject of the next and last section of the paper.

Transitional strategies: getting from here to there

It is easy to diagnose the world's ills – marginally less so to prescribe therapeutic remedies – but infinitely harder to carry these remedies out. Yet,

[55]Ashis Nandy, 'The Psychology of Colonialism: Sex and Age as the Idiom of Political Inequality in British India', to be published in Andre Beteille (ed.), *Aspects of Inequality*.

in the last analysis, it is the haunting issue of making a difference in the lives of people exploited and oppressed by the unholy alliance of power, privilege, and technology, which underlies the social validity of an intellectual exercise like this, and which compels me to sketch in, however imperfectly, some propositions to accelerate the millennial transition. What follows is not intended to be a comprehensive catalogue of concrete next steps, but merely a suggestive listing of possibilities, several of which are implicit or explicit in the preceding discussion.[56]

A. Creating autonomous Third World structures for economic and technological intelligence

We can begin at the international political level by stating a need, increasingly recognized by Southern spokesmen and leaders such as Julius Nyerere, to create truly autonomous Third World secretariat arrangements. The purpose in doing so is to engage in intelligence gathering and analysis essential to effective Southern bargaining with the North over political, economic, and technological issues. While UN agencies, such as UNCTAD, which are sympathetically oriented toward Third World aspirations have important roles to play in this area, their function, as Nyerere has observed, is to help reach international agreements. A Third World secretariat would develop, state, and press the Third World position. Without this kind of support, Third World negotiators are at a disadvantage, since they currently 'go to meet highly experienced people, armed with all the preparatory material done by sophisticated domestic and OECD staffs and their computers!'[57]

The particular form or forms such arrangements might take is for the Third World to decide. A variety of possibilities have been suggested by Francisco Sagasti, Ashok Parthasarathi, and others which related specifically to Third World scientific and technological collaboration, including the creation of a Third World association for technological development.[58]

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[56]For a rich collection of ideas for action see the various *IFDA Dossiers*, growing out of the IFDA 'Third System' project on the Third Development Decade (Geneva: International Foundation for Development Alternatives, 1978 and 1979).

[57]Julius Nyerere, 'Unity for a New Order', address to the Ministerial Conference of the Group of 77, Arusha, Tanzania, 12 February, 1979, as reprinted in the IFDA *Dossier* No. 5, March, 1979.

[58]Francisco Sagasti, 'Towards an Endogenous Scientific and Technological Development for the Third World', in Morehouse (ed.), *Science, Technology and the Social Order*, pp. 301–316, as well as his and Ashok Parthasarathi's contributions in W.K. Chagula, B.T Feld, and A. Parthasarathi (eds.), *Pugwash on Self-Reliance*, (New Delhi: Ankur Publishing House, 1977).

There is little that Northern well-wishers can say other than to underscore the need for these instruments and to actively pressure their governments, and the international organizations controlled or dominated by Northern interest, to see that obstacles are not placed in the way of such autonomous Third World structures for cooperation.

Such structures or arrangements can facilitate reverse penetration of the North by the South, especially by aiding access to key technologies (such as those coming from technological revolutions in micro-electronics and materials) which vitally affect Southern interests and prospects for surmounting the alliterative crises of the 1980s. Since there is already substantial Northern penetration of Southern societies through the systematic collection of social intelligence by national governments and multinational corporations, reverse penetration would, to use Stevan Dedijer's phrase, merely help to right the balance.[59]

B. Revitalizing indigenous technologies in the Third World

Initiatives like the Great Village Catalogue also play important roles in the millennial transition by documenting the successes of indigenous technologies, thus providing a basis for developing economic and political strategies to halt the destruction and displacement of these technologies. Closely related are efforts to document the destructive impact of Northern MNCs on the peoples of the Third World, especially on the poor majorities.

Perhaps even more important are social action programs built around the need for preserving and revitalizing indigenous technologies within the context of, to use Claude Alvares' felicitous phrase, 'a survival algorithm'. The venture which Alvares initiated in northeast Goa, RUSTIC, is one example. There are some other examples in India, about which I know a little, and undoubtedly many elsewhere in the Third World about which I know nothing. These ventures are typically focused on one or more localities where, instead of theorizing about the role of technology in social change, they are actually making a difference in fighting exploitation and striving to find ways to improve the lives of the poor.

But at least one caveat must be entered. Such ventures should not be confused with the broader category of rural development activities which profess to pursue 'alternative development strategies'. Some are genuine but many are bogus, designed more to ease the troubled consciences of urban elites than to help the rural poor cope with an increasingly

[59]Stevan Dedijer, various papers on social intelligence such as 'The IQ of the Undeveloped Countries and the Jones Intelligence Doctrine', *Technology in Society*, 1979, pp. 239–253.

hostile environment.[60]

For the most part, social action initiatives focused on revitalizing indigenous technologies should be left alone to do their own thing in their own way. Nonetheless, these kinds of undertakings, because they fly in the face of conventional thinking by development establishments in both the North and the South, do need support – when it is provided without strings. Hence, there is a need for agencies of this kind to be as politically neutral as possible in their support for local social action programs in the Third World (an example would be groups based in the more progressive smaller European countries). Even better, of course, is support from Third World sources themselves. Hopefully, such sources will multiply as we move through the millennial transition and it becomes increasingly apparent that conventional development strategies, based on wholesale intervention of environmentally destructive, energy-intensive Western technologies, do not alleviate but in fact exacerbate the position of the poor and economically marginal people in the Third World.

Linkages among these social action institutions must be developed within the Third World, perhaps regionally first and then on a broader basis. Even in a realm of activity, however, which seeks to further constructive social change by relying on less exploitative, more ecologically sustainable technologies the flow of information and contacts is still overwhelmingly from North to South – almost nil between Southern states. One Southern social activist–cum–indigenous technologist observes that almost 100% of his international mail comes from Euro–America, and concludes that such a situation is patently 'ridiculous'.

C. Realizing an 'economics of permanence' in the North

The foregoing are essentially Southern initiatives. No doubt Southern social thinkers and activists will come forward with others. For their counterparts in the North there is also a full agenda of work during the millennial transition, beginning with efforts to accelerate realization of what Barry Commoner calls the solar transition or Fritz Schumacher calls the 'economics of permanence', both of which are based on ecologically sound productive processes and the use of renewable natural resources. Only when the present

[60]Another caveat is to urge Northern well–wishers not to inundate these ventures with excessive attention. Unsolicited visits of outsiders both consume time and cause perturbation in local communities. A case can perhaps be made for an outside presence, perhaps a small group of social critics, giving public visibility to some particularly egregious form of local exploitation, but such exercises require the initiative and planning of the social action institution working on the ground.

socially and environmentally destructive and unsustainable Northern-dominated world system of production has been substantially transformed will it be possible to reduce in significant measure the present pattern of Northern de-industrialization of the Third World.

Life support systems are obviously crucial to human survival. Lewis Mumford once observed that the industrial revolution was characterized by the shift from using organism (e.g., plants and animals) to using machinery for the basic work of humanity.[61] If we are to reverse this set of relationships, at least in part, during the millennial transition (as we must to achieve an economics of permanence), our present position is at least better than it was in the past, because we have accumulated a wealth of knowledge from the study of self-sustaining ecological systems. To give an example from the work of the New Alchemy Institute, the metabolic response of algae to sunlight provides an aquatic environment conducive to producing food, in the form of fish, for large numbers of people through small- and intermediate-scale techniques with low capital inputs. The importance of light penetration to fish production was not known until recently.

Such work on technological development obviously needs to be extended greatly through use of advanced scientific techniques drawing on micro-electronic technology (among other things). Even more needed is widespread dissemination of such technologies in the North as alternatives to highly centralized, energy-intensive, environmentally destructive modes of production. Such dissemination will be enhanced by low-cost control and monitoring systems made possible through the application of micro-electronic technology.[62]

D. Curbing Northern de-industrialization of the South

One concrete step for coping with Northern de-industrialization of the South entails strengthening efforts to harness and control operations of Northern-based MNCs in Third World countries. The Transnational Institute in Amsterdam has made an important beginning in this area with a recently instituted 'Transnational Information Exchange'. Thus far, however, the exchange appears to be oriented more toward concerns of First World workers in fighting the increasing capacity of MNCs to manipulate

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[61]Lewis Mumford, *The Myth of the Machine: Pentagon of Power* (New York: Harcourt, Brace, and Jovanovich, 1970).

[62]I am indebted to Nancy Todd of the New Alchemy Institute for these paragraphs on the work done at the Institute and elsewhere in achieving an 'economics of permanence' (her letter of 20 October, 1979).

working conditions and workers in the First World (itself an important problem) than it is toward MNC penetration of Southern economies.[63]

Other measures to curb de-industrialization of the South by Northern MNCs include:

(1) Reducing or eliminating certain incentives (such as deferral of corporate taxes on foreign income or investment guarantees) granted to MNCs by Northern governments to extend their operations into the South.

(2) Policing more effectively the practice of transfer pricing which enables MNCs to extract handsome, sometimes exorbitant, profits from their Third World operations. Both Northern and Southern governments have a role to play in curbing this practice which results in hundreds of millions of dollars of tax evasions each year.[64]

(3) Requiring observance by MNCs of the same environmental, antitrust, restrictive business practices, and other social standards which they must observe at home whenever they move offshore, especially into Southern countries.

A full program of de-industrialization curbs, the principal ones of which are indicated above, is explicated elsewhere.[65]

E. Grappling with the technological displacement of workers in industrialized countries

The work of the Transnational Institute and other bodies interested in protecting the position of Northern workers points up a particularly critical need as the micro-electronic revolution gathers momentum in the 80s – namely, to increase knowledge about the potential impact of such technology in order to broaden social control. Employment, already a critical problem in the Third World, will become a key political and economic issue in industrialized countries as well in the 1980s, and will provide both promise

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[63]Transnational Institute, *Transnational Information Exchange*, Occasional Newsletter.

[64]Just how widespread is the practice of transfer pricing and how substantial is the evasion of corporate income taxes is revealed in the results of a US Internal Revenue Service audit of the overseas operations of 871 US corporations. Transfer pricing was found in more than half the cases, resulting in an assessment of $662 million in additional taxes over the two-year period covered by the audit (*New York Times*, 21 August, 1977).

[65]See Ward Morehouse, 'Dominance, Equity, and Technology: Ambivalence and Conflict in U.S. Policy toward the Third World', *Columbia Journal of International Affairs* Spring/Summer, 1979, pp. 111–128, and *Science, Technology, and the Global Equity Crisis: New Directions for United States Policy* (Muscatine, Iowa: The Stanley Foundation, Stanley Foundation Occasional Paper No. 16, 1978).

and peril in working toward the millennial world order goals of the twenty-first century.[66]

So-called appropriate technology – decentralized, small- and intermediate-scale, labor-intensive, ecologically sound – is urgently needed in Northern countries to cope with the technological displacement of workers. This requires re-examination of existing economic rules which often subsidize or give unfair advantage to the large-scale sector (e.g. in the cost and availability of credit and investment capital).[67] We must also reexamine the present system of technology ownership so that technologies with a high degree of social merit (e.g. in their capacity for generating meaningful and productive work) can be made freely available.

F. Technology assessment and other global-level initiatives

At the global level, innumerable transition possibilities exist. In a recent paper on 'A New International Technological Order', Johan Galtung argues for greatly broadened activity in this area and for North–South collaboration in the development of more socially and environmentally appropriate technologies. With regard to technological assessment, he urges that:

> In addition to the economic and environmental criteria, we should also add more explicitly the social and cultural dimensions. Assessments should be made public, including warnings. If it is possible to reduce smoking in industrialized countries, at least among middle-aged males, by means of a campaign where prospective buyers of tobacco products are warned that they may be 'dangerous to your health', it should also be possible to reduce some of the abuses of technologies by issuing warnings to the effect that they may be dangerous to individual as well as social 'health'. It would be interesting to see what conclusions joint North–South commissions working on such problems might arrive at. It is quite clear, though, from past experience that the problem is not whether the composition of the commission is international, but whether it is sufficiently interdisciplinary, whether it includes a sufficient number of perspectives on technology, and also whether it includes people who are not intellectuals and who, for that reason, do not have our *deformation professionelle*.[68]

The task of working together to develop technologies better suited to

[66] We are not lacking in ideas on what should be done; see, e.g., various issues of the newsletter, *Turning Point* (issued from London by James Robertson and Alison Pritchard) and various contributions, such as those by Ignancy Sachs, to the IFDA *Dossier* on what to do about problems in industrialized countries.

[67] The AT for the UK program of the Intermediate Technology Development Group in London is initiating such a project. See *Appropriate Technology in the United Kingdom* newsletter ably written by the program's director, John Davis.

[68] Johan Galtung, 'Towards a New International Technological Order, *Alternatives IV*, 3, January 1979 (Special issue on Science and Technology), p. 297, reprinted in Ward Morehouse (ed.), *Science, Technology and the Social Order*.

realizing millennial goals should provide a good basis for North–South cooperation on an equal footing.

The South can contribute deep insights into traditional technology; the North can provide what has been developed recently and what is very quickly being developed in the field of alternative technology. Thus, an economic profile that might emerge would include the type of technologies that are nature-extensive, capital-extensive, labour-intensive, research-intensive and organization-extensive. In other words, the major inputs would be labour and research, work and ingenuity. It may well be that recent advances in new ways of producing foodstuffs, based on a much broader utilization of nature eco-systems, would fall into this category.[69]

Galtung goes on to suggest that we need to develop new channels for the transfer of technology:

When we say transfer 'from North to the South', it is actually a non-valid metaphor; in fact, it is a transfer from certain groups in the cities of the North to certain groups in the cities of the South. It is urban–urban cooperation, which leads one to ask the question what rural–rural cooperation might look like. What would happen if a more direct dialogue and cooperation were to take place between rural communities – for instance, communities which try to become more self-reliant, whether they are located in southern Tanzania or northern Norway? Today they may articulate demands or needs imposed upon them but the channel through which a dialogue and possible cooperation can take place would be the negotiating elites drawn mainly from the two capitals concerned, in bilateral or multi-lateral settings.[70]

G. Stimulating South to North technology flows

In the light of the enormous flow of technology today from North to South, some attention to flow in the other direction is certainly merited. In general, Galtung argues, such technology flows would not involve the traditional technology of the South.

Such technology would usually be as unsuited to the North as Western technology is to the South. The only condition under which such transfer would be possible would be the reverse of the condition that has obtained in the world; this means 500 years of domination of the South over the North preparing the ground. This condition not obtaining, what is of interest today is more openness in the North to consider new ways of developing 'mixes'. One interesting example of this is how Japan, a country which one century ago would have been classified as belonging to the 'Third World,' was able to build a buffer around Western technology, encasing it in a social structure somewhat different from the Western one. Today there is transfer of technology from the North to the South and the beginnings of technical cooperation between the South and South (TCDC). It is high time some patterns of transfer of technology from the South to the North emerged.[71]

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[69]ibid, p. 297–298.
[70]ibid, p. 299.
[71]ibid., pp. 298-299.

A Northern-based intermediate technology group has recently formed the Intermediate Technology Development Group of North America which seeks to initiate, as one of its basic areas of activity, a series of projects involving South-to-North technology transfer.[72]

Clearly, there is need for restructuring international institutions, although as long as intergovernmental agencies such as those of the UN system are controlled by national governments, as by their very nature they are, this will be difficult.[73] Nongovernmental channels of cooperation and dialogue may offer greater opportunities to pursue the tasks of the millennial transition. Some proposals for action by NGOs were made at the NGO Forum at UNCSTED in August 1979. Numerous other ideas are contained in the *Dossiers* generated by the 'Third System' project of the International Foundation for Development Alternatives in Geneva.[74]

H. Redefining the nature of work

Historically, work has been closely linked to economic productivity, certainly in the industrialized market economy countries. As changes in technology, especially through automation, bring about radical changes of economic productivity, new definitions of 'social productivity' will have to be used as a basis for allowing income if the political tensions inherent in a dual economy (high-wage, high-productivity sector versus low-wage, low-productivity sector) are to be contained. Under the best of circumstances, the battles over intersectoral division of income in these economies will be fierce in coming decades, and ability to forge consensus around a definition of work which takes account of 'social merit' in determining income (e.g., nonalienating work of low economic productivity which is also ecologically sound) will not be easy.

In highly industrialized societies with advanced technology, workers are increasingly 'deskilled', less autonomous, and more dependent on goods

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[72] Intermediate Technology Development Group of North America, Statement of Organizational Goals and Program Interests, New York: ITDG/NA, December, 1979. The basic purpose of the Group is to promote the use of so-called appropriate technology in North America, *not* the development of such technology for export to the Third World.

[73] See 'The Role of Non-Governmental Organizations in Mobilising Science and Technology for Development', Draft discussion paper for the NGO Forum at the UN Conference on Science and Technology for Development, Vienna, 19-29 August, 1979; and Ward Morehouse, 'Converting Hot Air into Forward Motion: The Role of NGOs in Working Toward the Goals of the UN Conference on Science and Technology for Development', *Science and Public Policy*, Summer 1979.

[74] *IFDA Dossiers*, various issues in 1978 and 1979.

and services purchased from others than they are on goods and services provided by their own efforts. In traditional societies, much less 'deskilling' has occurred. The millennial transition provides an opportunity to reverse the trend toward 'deskilling' as workers demand more psychologically and socially meaningful forms of productive activity.[75]

I. Researching the powerful: A moratorium on research on the poor

Yet another transitional strategy entails inverting existing priorities in social research by concentrating investigatory interest on the rich and powerful. This plea was forcefully made by Martin Nicolaus a decade ago:

> The corporate rulers of this society would not be spending as much money as they do for knowledge, if knowledge did not confer power. So far, sociologists have been schlepping this knowledge that confers power along a one-way chain, taking knowledge from the people, giving knowledge to the rulers.
>
> What if that machinery were reversed? What if the habits, problems, secrets and unconscious motivations of wealthy and powerful were daily scrutinized by a thousand systematic researchers, were hourly pried into, analyzed and cross-referenced, tabulated and published in a hundred inexpensive mass-circulation journals and written so even the fifteen-year-old high school drop-out could understand it and predict the actions of this landlord, manipulate and control *him*?
>
> Would the war in Vietnam have been possible if the structure, function and motion of the U.S. imperial establishment had been a matter of detailed public knowledge ten years ago?[76]

By the same token, Claude Alvares argues, it is time to declare a moratorium on research on the poor:

> The studies on the Green Revolution, on the pernicious effects of multinational corporations and the abuses of corporate power in the industrial nations themselves, much less the Southern nations, are legion. There are any number of studies on the poor, and this is my principal complaint. For, in any context in which the poor are oppressed by elites, any further information will always be used against them. It seems reasonable to propose a moratorium on all studies on the oppressed.[77]

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[75] I am indebted to Ashis Nandy for raising this point. He goes beyond the question of alternative types of work to identify another form of activity – namely, non-work which in traditional societies may be more culturally meaningful than alienating, 'deskilled' work characteristic of industrialized societies (Letter from Ashis Nandy, 15 October, 1979).

[76] Martin Nicolaus, Address to the 1968 Convention of the American Sociological Association, as quoted in Alvares, *Homo Faber* (f.n. 10), p. 240.

[77] Alvares (f.n.10), pp. 239-240.

The politics of technological revolutions

Technological revolutions in the past, Claude Alvares insists, have always resulted in further exploitation of the poor and oppressed.[78] Why should the revolutions in materials and micro-electronic technologies, which I have identified as key elements in the millennial transition, be any different?

We cannot be certain, of course, that the result will be different. A major imperative underlying attempts to stimulate public debate on, and scrutiny of, technological revolutions *before* they strike with full force is to set in motion liberating political forces so that new alliances will be formed to seize control of these technologies and use them as instruments to alleviate conditions of the past rather than as instruments of further exploitation.

There are other factors as well which suggest at least the possibility of such an outcome:

(1) Certain new technologies are relatively less susceptible to monopolistic or oligopolistic control than others (look at the spread of pocket calculators, a direct result of the dramatic cost reduction made possible by the silicon chip).

(2) Micro-electronics offers the promise, not only of tremendous increases in productivity, but also of new kinds of productive activity to meet basic material needs. The chief way in which this would occur is through a marriage of micro-electronics and biotechnology, both characterized by low capital inputs and susceptibility to widespread decentralization.

(3) Much of this new ecologically sound technology is being developed by persons and groups, such as the New Alchemy Institute, committed to working toward the millennial goals of justice, peace and ecological balance.

(4) The breakdown of the dominant world production system – characterized by massive consumption of non-renewable resources and destruction of the life-sustaining capacity of the biosphere – which became serious enough to attract widespread attention in the industrialized countries in the 1970s will compel action toward alternative patterns of production based on an 'economics of permanence', as conditions continue to deteriorate in the 1980s and 1990s.

(5) The same breakdown, now beginning to penetrate public consciousness in the Third World, will compel a reexamination of the role of indigenous or survival technologies as the breakdown continues into the remaining decades of the twentieth century.

The key issue in the politics of any technological revolution is control.

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[78] ibid.

The task at hand, if we are to achieve the goals of the millennial transition, is to capture direction of these revolutions from below. In doing so, we must work actively to build new North–South alliances dedicated to common social goals – for example, Northern consumer, environmental, and worker groups collaborating with counterpart groups in the Third World.

But these kinds of collaborative relationships cannot be mere repetitions of occurrences in the 1950s, 1960s, and 1970s, when the flow of ideas and intellectual direction was heavily from North to South. Achieving the goals of the millennial transition will require continuing and accelerated emergence of autonomous Third World institutions. This is an essential precondition to meaningful cooperation at the global level. For varying periods of time in different arenas of concern and action, Third World initiatives will be called for, even if these initiatives receive less financial and other resources than their Northern counterparts. Primary international ties must be forged at the regional level and only loosely linked at the global level.

Techniques for this kind of collaboration are hardly new but may reflect different mixes of activities. For example, more emphasis may be placed on small workshops which try to achieve direct social impact, and on small-scale research and testing of new technologies. Certainly communication of ideas and experience at all levels – local, national, regional, and global – will continue to be important, perhaps even more so in the future. Mechanisms to facilitate dialogue on social consequences of technological choices should be explored at all these levels, either by strengthening what already exists or, where clear unmet need can be demonstrated, by creating new mechanisms.

Inequity in one form or another will persist in the world far into the next millennium. But we are more likely to achieve the millennial goals of peace, social justice, economic well-being and ecological balance and to develop the technologies to support these social goals if the world passes first through a transitional period of disengagement, leading to the emergence of more autonomous social organisms. In the never ending quest for greater equity in our troubled and unequal world, we must continue the search for, and implementation of, strategies designed to weaken the strong and strengthen the weak.

The shape of the human community in the next millennium

While the quest for autonomy is a vital element in the struggle for greater equity, the ultimate goal is to achieve a new integration of the human community within the framework of self-realization and agreed-upon values.

The objective of the millennial transition is to replace the present world order based on dominance, violence, and exploitation with a new structure, the essential characteristics of which have been aptly described by Rajni Kothari:

> The philosophical perspective that should guide such an endeavor should steer clear of both imperialist claims to universality and the normless striving for relativity: it should affirm both the principle of *autonomy* of each entity (human as well as social) to seek out its own path to self-realization and the principle of *integration of all* such entities in a common framework of interrelationships based on agreed values. The world as it is at present constituted violates both autonomy and integration as principles informing human arrangements. It is a world based, instead, on a framework of dominance that works through endless fragmentation and tensions, one that relies heavily on instruments of violence and institutions of inequity. It is only by seeking a new structure of the world, and as a basis thereof, a new approach to technology and a new ethic of interrelation between cultures and polities that there will be scope for drawing upon the richness of diverse human experiences and realizing alternative modes of human fulfillment.[79]

[79]Rajni Kothari, Foreward to Claude Alvares, *Homo Faber* (f.n. 10), p. xiii.

APPENDIX 1: DEFINITION OF TERMS AND CONCEPTS

Autonomy

A central theme in this paper is the quest for autonomy. I define autonomy simply as 'self-control'. It reflects a relative rather than an absolute condition. To the extent that autonomy is a social good, the task at hand is to seek ways of increasing the autonomy of individuals, institutions, communities, and nations, with particular attention to technology as an instrument to achieve that end.

In this visionary perception of what the social landscape should become, merely increasing the autonomy or self-control of individuals, institutions and other human aggregations is not enough and could be quite destructive unless two further qualifications are met.

The first and most important concerns the impact on others of increasing the autonomy of individuals or groups. If increasing the autonomy of some can be accomplished only by decreasing the autonomy of others, the net effect may not be social progress.

Much depends, of course, upon the extent to which the people whose autonomy might be increased would be exploitive of others. But we need not assume that the growth of social or technological autonomy is a zero-sum game. Certain initiatives may have the net effect of increasing everyone's self-control. It should be recognized, however, that for the most part increasing the autonomy of the poor and oppressed, those who now have least self-control over their lives, involves sustained conflict with those who exercise dominance and control over them.

The second qualification concerns the sustainability of increased autonomy. Transient adjustments are not likely to accomplish a rearrangement of the social landscape along more autonomous lines if the old landscape resurfaces once the impetus for change disappears. This consideration applies with particular force to initiatives undertaken by people external to a given social setting, no matter how well intentioned or motivated. Such initiatives can all too easily become transient interventions in poor people's lives; when the intervention ceases, the poor are left once again to the tender mercies of their previous exploiters.

Sustainability implies that the thrust toward greater autonomy must come from individuals and groups. Here, some social realists would argue, is the rub: some individuals or groups may prefer more dependent relationships

to those that allow for greater autonomy. But such individuals or groups may never have fully understood what alternative social relationships might mean for them. And they will almost certainly never have experienced these arrangements – an opportunity they should have before greater autonomy is rejected in favor of greater dependence. At a minimum, we need an open and vigorous debate on social alternatives.

Others would argue that such a visionary social goal ignores the real functions performed by authority, hierarchy, and control structures in human societies. These social phenomena constitute the glue which holds individuals and groups together and which enables them, through collaborative effort, to accomplish larger objectives than would be possible if they all acted singly. I do not dispute the social significance of these phenomena. I feel constrained, however, to point out that, since we are dealing with relative rather than absolute conditions, it is possible to have collective effort based less on excessive authority of rigid hierarchy and control than on cooperation. Indeed, in the long-term interest of sustaining human existence in our frail biosphere, we need to press the quest for more autonomous patterns of social organization and technological choice far more vigorously than we have in the past. Autonomous patterns would increase the element of individual and group control over destinies in a manner consistent with the qualifications mentioned above. The realistic objective is to obtain a better mix of large and small, centralized and de-centralized systems of production of goods and services and other forms of social activity.

Is autonomy merely another label for self-reliance? Much depends, of course, on who is defining the terms. In some cases, the terms are probably equivalent, but my reservations about self-reliance (as a label, not as a goal) stem from its appropriation as a political slogan by Third World governments. My conception of autonomy is much broader, encompassing industrialized societies and social, cultural, intellectual, and technological phenomena, as well as political and economic behavior of Third World governments.

Technological autonomy

Of central concern in this paper is technological autonomy. My working definition of technology is simple and straightforward: the skills, knowledge, and tools needed to make useful things (things being understood to include services) *and* the social process involved in making such things acquired through the interaction and use of skills, knowledge, and tools. Technology is thus an important carrier of economic and political relationships within and among societies and other social groups. Technological autonomy is

merely a shorthand way of describing the autonomous capacity for creating, acquiring, adapting, and using technologies necessary to meet a society or community's own economic and social needs.[1] Like the broader concept of social autonomy, it is not an absolute but a relative condition and therefore involves increasing capacity for autonomous decision-making in the realms of choice and use of technologies. This includes control over the acquisition and use of external technologies as well as the generation of indigenous technologies.

Technological autonomy is a dimension crosscutting the economic, political, social, and intellectual autonomy of social groups. It is difficult to envisage technological autonomy independently of these other forms of autonomy (although one or two possible examples can be found), just as it is hard to imagine other forms of autonomy developing very far without a significant increase in technological autonomy.[2]

This autonomous capacity for technological change does *not* mean autarky or isolation, although it may involve selective disengagement from a larger economic and political system for periods of time while indigenous problem-solving capabilities are strengthened. Technological autonomy does not mean that a society must reinvent the wheel but rather that it should have the ability to do so if it had to. It certainly involves the capability to improve upon wheels invented elsewhere.

Equity

Another key concept in this treatise on millennial transition is equity – presumably, the overriding social goal of that period. Equity as a social goal has four principal components:

(1) Meeting the minimum material needs of most, if not all, members of a social group, whether it be a local community or a nation-state.

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[1]For a fuller statement of technological autonomy, see Ward Morehouse, *Technological Autonomy and Delinking in the International System: An Alternative Economic and Political Strategy for National Development* (New York: UNITAR, Science and Technology Working Paper Series No. 2, 1979), especially pp. 6–11.

[2]If Gustav Ranis's comparative analysis of Taiwan and the Philippines is to be taken at face value ('Appropriate Technology in the Dual Economy: Reflections on Philippine and Taiwanese Experience', Paper prepared for International Economic Association Conference on Economic Choice of Technologies in Developing Countries, Teheran, Iran, 18–23 September, 1976), Taiwan may be one example of a country obviously dependent politically in the international system which has nonetheless achieved a certain measure of technological autonomy.

(2) Providing opportunities for meaningful and productive work for most, if not all, members of the group able to work.

(3) Providing more equal income distribution, which leads to satisfaction of basic social requirements and wants (health care, education, etc.) of most, if not all, people.

(4) Similarly, increasing satisfaction of major nonmaterial needs (such as individual freedom, identity, and self-expression) of most, if not all, people.[3]

Equity in its simplest formulation means fairness and, like autonomy, it is clearly a relative rather than absolute condition. The socially operational way of describing equity as an objective is the need to work toward *increasing* parity among members of various social groups ranging from the family and local community to the nation-state. Working toward greater social equity is a never-ending task for all societies at all levels of development and will engage the creative and constructive energies of the human community throughout the coming millennium. The urgency surrounding equity as an overriding social goal arises from the challenges it will face (and already faces) during the next 20 to 40 years of the millennial transition. These challenges are being sustained and exacerbated by political and economic manipulation of some existing and emerging technologies. At the same time, emerging or 'transitional' technologies offer a means, given the right combination of political and economic forces and dispositions, of responding to these challenges.

In order to understand the significance of technological autonomy and social equity in the millennial transition, it is necessary to examine their interrelationship. We do not have evidence to support causality – i.e., the idea that greater autonomy will necessarily lead to greater equity – but there is evidence to support a positive correlation between the two (e.g., few Third World countries have moved very far in meeting the social equity goals defined above on a sustained basis without considerably increasing their autonomous capacity for technological change). And I see precious little evidence that significantly greater and sustained equity can be achieved in the absence of increased technological autonomy and in the presence of continued domination and dependence.

Autonomy, whether social, political, economic, intellectual, or technological, is no panacea. There will almost certainly be exploitation and brutality

[3] I eschew the phrase 'basic human needs' because it is fraught with misunderstanding and has to some extent, been appropriated and used by the wrong people for wrong purposes. But for a forward-looking definition, see the list of basic human needs prepared by Johan Galtung, Director of the Goals, Processes and Indicators of Development Project (Geneva: United Nations University/UNITAR, 1977).

within the more autonomous nation-states of the First and Second Worlds today (concentrated in exploited and oppressed social groups within these societies, that lack autonomy most). But I do argue, on the basis of correlative evidence at hand, that the prospects for greater equity will be sharply increased to the extent that greater autonomy is realized in the next millennium.

The relationship of science and technology

Most efforts to address the issues explored in this paper simply bracket science and technology as though they were, if not the same thing, so clearly linked as to be indistinguishable. There is also a set of assumptions, usually unarticulated, that 'modern' technology depends upon, and is derived from, science, that such technology is superior to 'traditional' technology, and therefore, that 'modern technology' is naturally desired by all societies, rich or poor, in greater and greater measure.

One reason for the failure of the United Nations Conference on Science and Technology for Development held in Vienna in August 1979 to stimulate debate (not, it may be recalled, action on critical issues underlying the present human predicament) was the unwillingness of those shaping the UNCSTED agenda to examine these implicit assumptions. WOMP sought to draw attention, a year before UNCSTED, to certain underlying issues through the Poona Indictment on 'The Perversion of Science and Technology.' While the Poona Indictment was widely noticed and may have had some impact on discussions among nongovernmental organizations, it had no discernible impact on the official UNCSTED proceedings conducted by national governments and UN agencies.[4]

One way to examine the relationship between science and technology is to visualize a continuum with 'pure' science, at one end, and pure technology, at the other. In this polarized form, science and technology are quite distinctive activities, the former directed toward knowing and the latter toward doing. Both are concerned with the natural world and human interaction with it, and, as they move toward the center of the continuum, they become less and less distinguishable.

Although there is no question that 'modern' technology is closely related to science, it is less clear whether the relationship is causal and, if it is, which

[4]The text of the Poona Indictment, first carried in *Alternatives IV*, 3, January 1979, has been published in various places, including the *Bulletin of Atomic Scientists; International Development Review* (Special Issue on UNCSTED and WCARRD), 1979/2; *IFDA Dossier*.

way the causality runs. Historically, as Derek Price has pointed out, scientific advances were derived from technology (notably through accomplishments of instrument makers who made many of the scientific investigations in the early stages of the Scientific Revolution in the West possible.)[5] Today there is ample evidence that the utilitarian thrust of technology directs the course of much basic scientific research. Indeed, it is the prospect of aggrandizement of economic and political power which has led to large scale public patronage of basic research in rich countries in the last 30 years. The Second World War, with the development of radar, nuclear weapons, and other science-based technological 'advances', demonstrated that there was enormous potential payoff in doing so.

Thus, science can sit behind the fig leaf of social neutrality no more than technology can. Even a presumably benign field of inquiry, such as food and nutrition sciences (upon which knowledge concerning growing, preserving, and processing food and the impact of these patterns on the well-being of people is based), is not immune from the dangers of irrelevance or, positive injury if the wrong goals are served. According to the Food Study Group on the UN University's Goals, Processes, and Indicators of Development Project:

> In the narrow sense, nutrition and food science may be concerned with the composition of food in terms of energy and nutrients and by extension, with the technology of storing, processing and preserving food. Such preoccupations may, however, lead to the standardisation of diets and to depriving people of control over traditional patterns of food production and give control over food to a privileged class with the power to manipulate standardisation and quality control for profit and power motives.[6]

The role of traditional or indigenous technologies is explored in the body of the text in the context of an examination of lessons from the past, crises of the present, and transitional technologies for the future. Suffice it to say that advocacy of revitalizing traditional or indigenous technologies in all societies (not just the Third World) does not negate the importance of developing a strong science base in societies now lacking such a base. The critical issues for the Third World are: to avoid creating a science establishment largely derivative of the First and Second Worlds; to prevent North-South science flows (undertaken always in the name of 'international cooperation') from perpetuating intellectual dependence, and for all

[5]Derek J. deSolla Price, 'Is Technology Historically Independent of Science? A Study in Statistical Historiography', *Technology and Culture*, 1965, pp. 553–568.

[6]United Nations University, World Hunger Programme/Human and Social Development Programme, Joint Workshop on Goals, Processes and Indicators for Food and Nutrition Policy and Planning, Massachusetts Institute of Technology, 26–29 March, 1979, *An Issues Paper*, contributed by the Food Study Group on the Goals, Processes, and Indicators of Development Project (GPID).

countries; to restore scientific inquiry to its original purpose.[7] In the words of the Poona Indictment:

> Something is seriously wrong. What started as a liberator of the human spirit and held the promise of 'happiness and plenty' for all has resulted in inequity, exploitation, alienation and apathy. Far from being an instrument of human salvation, modern science has gone on a course that threatens survival itself . . . Humanity must regain its sanity by reasserting the nature of scientific inquiry as the pursuit of truth, leading to technologies which liberate the many rather than facilitate control by the few.[8]

[7] The Pugwash Guidelines for International Scientific Cooperation for Development contain a number of useful suggestions; for the text, see *Alternatives IV*, 3, January 1979. pp. 417-427.

[8] *Alternatives IV*, 3, January 1979, pp. 413-415. Ashis Nandy argues that the pathology of Modern science provoked, in the first instance, by the context of science, has now entered the text of science itself. (Letter from Ashis Nandy, 15 October, 1979.) This rests on the assumption that science is substantially autonomous. I am less convinced of the autonomy of modern science, certainly in broad direction (leaving the possibility that individual scientists may pursue their work largely autonomously). I am as yet unconvinced that modern science is inherently pathological, although some scientific activity in recent times has certainly led to pathological results.

APPENDIX 2: GLOBAL MALDISTRIBUTION OF MODERN SCIENCE AND TECHNOLOGY

The late twentieth-century world is a pretty unequal place, no less so in the obscene imbalance in global distribution of science-based problem-solving skills than in other respects. Because these skills assume increasing importance as determinants of economic and political power as we enter the millennial transition, their future distribution is almost certain to have a significant impact on the capacity of different societies to cope with alliterative crises of that transition period – energy, environment, employment, and equity.

The issue of global distribution of scientific and technological capacity has also assumed a measure of political topicality since the Group of 77 proposed to the UN Science and Technology Conference in Vienna that a target of 20% be set for developing countries in carrying out world research and development by the year 2000.[1] That target is insufficient in magnitude and incompletely conceived in terms of social consequences. To explain these reservations requires a brief excursion into the realm of global R&D statistics.

Such statistics, shaky at best when they are aggregated at the world level, are often cited in UN documents and at international conferences as though they possessed great reliability. The most frequently quoted figures, until recently, were based on calculations from 1963–1964 data, indicating that 98% of the world's R&D expenditure was accounted for by the industrialized countries and only 2% by the Third World.

More complete and methodologically substantial figures based on 1973 data became available recently through the work of Jan Annerstedt and a small research group working out at the Roskilde University Center and University of Lund in Denmark and Sweden under OECD sponsorship. Although Annerstedt is careful to point out the large areas of uncertainty in such data, his figures are more comprehensive than the 1963–1964 figures (he covers China, the Soviet Union and East Europe, which were omitted in the earlier exercise), and his group has gone to considerable lengths to

[1]Although the target did not gain acceptance in the Vienna Programme of Action, it, or something similar, will almost certainly surface in the future as a recurring part of the so-called North-South dialogue.

cross-check official government data with unofficial sources.[2]

Because the 1973 figures are more comprehensive, comparisons with a decade earlier are at best approximate. But if all countries covered in 1973 were included in the 1963–1964 figures, Annerstedt estimates that the Third World share would have been more like 1% in the early 1960s and was 3% a decade later. Since world R&D expenditures more than doubled (at constant prices) during this period, a triple increase in the Third World percentage represents no small achievement, even though global distribution of R&D remains badly skewed.

Science and technology capacity is not only badly skewed between North and South but also within both regions. The two superpowers, between them, account for 60% of the world total. Add Japan, West Germany, France, and Britain, and the percentage increases to 83. Even within the Third World, distribution is sharply skewed. In Latin America, for example, three countries (Argentina, Brazil, and Mexico) account for 70% of the R&D expenditure in that region. And in Asia, India and China dwarf all other countries.

R&D inputs are also typically measured in manpower. Here we lack earlier global figures but, in 1973, Annerstedt calculates the Third World share was little more than 11% of the global total. From what is known about the growth of scientific and technical manpower in a few major Third World countries (such as India) since then, it seems quite likely that by 1983, the 20% goal of the Group of 77, if measured in manpower, will have been met – or at least will be close at hand.

Even if the Group of 77 goal for UNCSTED is measured in money, it may be realized by simply allowing present trends to contine without any special effort by the international community. While projections from such a small base are clearly speculative, reducing the present ten-year tripling time to reflect only a doubling of R&D expenditures would mean that the Third World share would be 24% by the year 2003.

In short, this G-77 target, whether measured in money or manpower, is insufficient. If science-based problem-solving skills are really becoming more and more critical for the foundations of economic and political power in the late twentieth-century world, and if these skills are a key to surmounting the crises upon us as we enter the millennial transition, then nothing less than parity will do. The target should be to achieve a global distribution of R&D, whether measured in money or manpower, which matches the

[2]Jan Annerstedt, *A Survey of World Research and Development Efforts: The Distribution of Human and Financial Resources Devoted to Research and Experimental Development in 1973* (Paris and Roskilde, Denmark: OECD Development Centre and Institute of Economics and Planning, Roskilde University Center, July, 1979).

distribution of world population. Thus, if present population patterns continue, the Third World should have 70–75% by the time the target is realized. This, it will be argued, cannot be done in 20 years, so let us double the time period to the outer extremity of the millennial transition – the year 2020 – setting an interim goal of being half-way there (or 35–40%) by the year 2000.

The real question about R&D effort, however, is not input but output. Unless we are able, in the words of the Poona Indictment, to reassert 'the nature of scientific inquiry as the pursuit of truth, leading to technologies which liberate the many rather than facilitate control by the few', merely increasing R&D activity in the Third World will not enable it to surmount the crises of the millennial transition and indeed may exacerbate those crises.[3]

It is almost impossible to measure R&D output in any remotely rigorous way on a comprehensive international scale, but the distribution of R&D inputs by social function provides a crude yardstick. Here the whole world, North and South, is off course, with almost half of global R & D currently devoted to destructive purposes. As long as we are discussing targets, why not set another for all nations: a *maximum* of 20% spent on military R&D by the year 2000?

Many students and practitioners of international relations, particularly in the dominant Northern half of the world, decry target-setting as an exercise in futility. Such critics overlook the importance of targets as political statements and normative goals. Achieving global parity in science-based problem-solving capacity by the end of the millennial transition and cutting the proportion of socially destructive R & D by more than half by the end of this century are surely worthwhile objectives for the human community.

[3]Ashis Nandy raises the intriguing question of whether, given the distorted distribution of scientific effort in terms of social function, the Third World may be better off with only 3% – or 5 or 11% – of the world's scientific resources (Letter from Ashis Nandy, 15 October, 1979). Possibly, but to the extent Northern domination of the South is bad for the latter, the South has been adversely affected by the global maldistribution of these resources which have become a major instrument in maintaining Northern dominance in the world.